OLOGY DEPT.

TECHNOLOGY REVIEW

July 1957

V. 59 - #9

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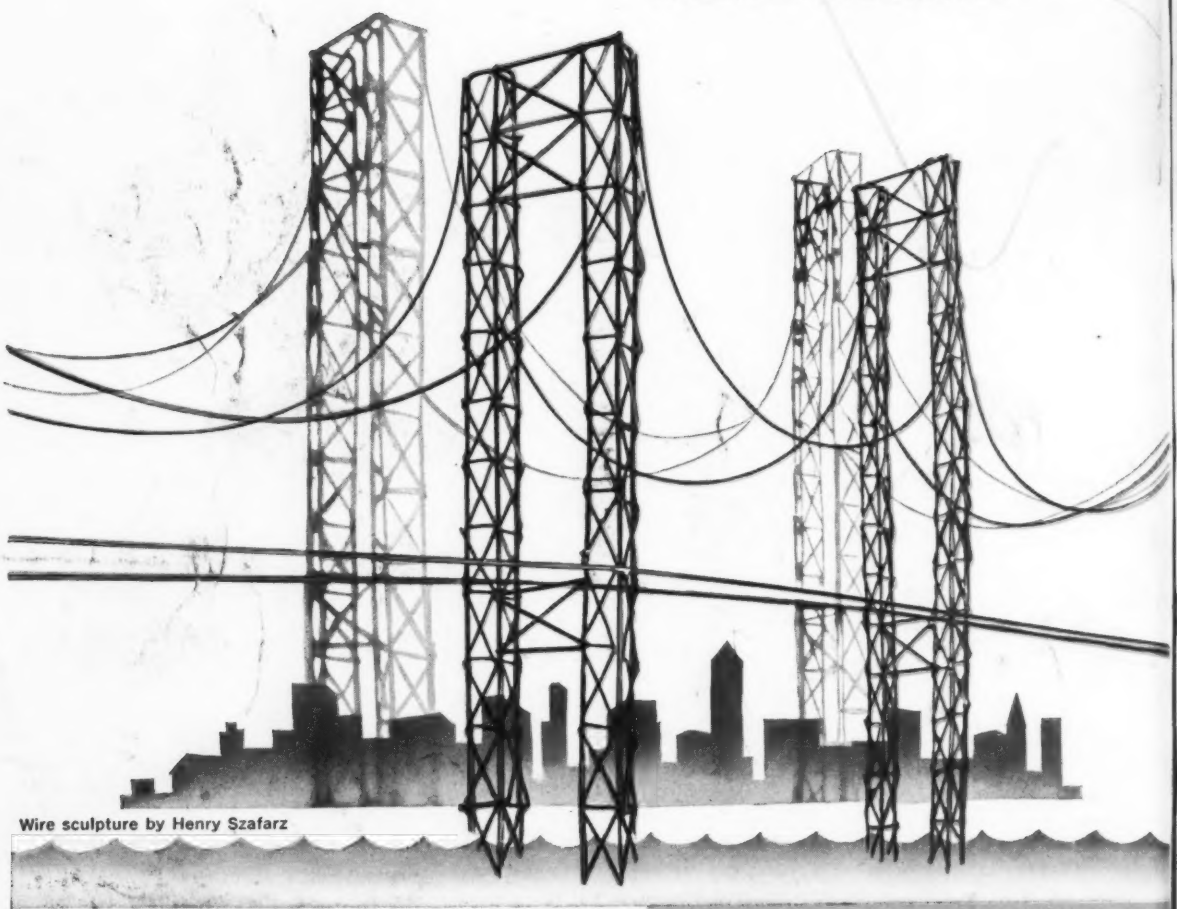
DETROIT

"Monument to Power"

Every engineered structure stands as a tribute to the men who planned and built it. And to the efficiency of their equipment, too.
Simplex-ANHYDREX cables, for instance, which are used everywhere for power distribution, control, floodlighting and numerous other functions. These expertly-engineered cables are equally suitable for overhead or in-the-ground use. They resist sunlight, ground acids, alkalies, oil, heat and flame, and their ANHYDREX insulation makes them super-resistant to water.

SIMPLEX WIRE & CABLE CO.,
79 Sidney Street, Cambridge 39, Mass.

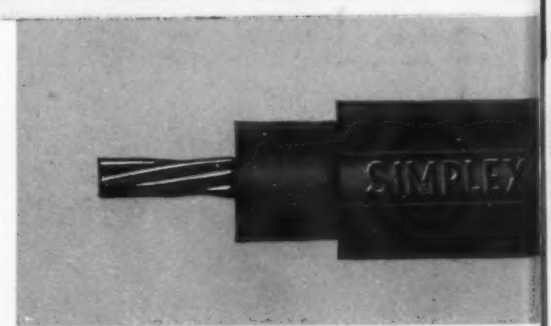


Wire sculpture by Henry Szafarz

Simplex

LIVE BETTER ELECTRICALLY

ANHYDREX



Now! Constant Damping Without Warm-up

Linear Accelerometer
Type LA-500
Shown actual size.

LINEAR ACCELEROMETERS
for Aircraft and Missiles

HONEYWELL LINEAR ACCELEROMETERS of the Type LA-500 Series are true linear, non-pendulous type instruments, inherently insensitive to cross-coupling accelerations. These instruments are available in a variation of ranges from ±1 G to ±60 G and can be provided with two potentiometer pickoffs. Essentially constant damping is maintained automatically throughout the entire operating range of −65°F. to +175°F. No warm-up time is required.

The combination of constant damping, high performance, small size and ruggedness makes HONEYWELL LINEAR ACCELEROMETERS of the Type 500 Series ideally suited for aircraft and missile applications where the most severe environmental conditions are encountered. Write for Bulletin LA-500, Minneapolis-Honeywell, Boston Division, Dept. 1, 1400 Soldiers Field Road, Boston 35, Mass.

DESCRIPTIVE DATA

- **RANGE:** Up to ±60 G full scale.
- **DAMPING RATIO:** 0.6 ±0.2 (from −65°F. to +175°F.).
- **LINEARITY:** 1% of full scale.
- **PICKOFF:** Can be provided with 2 potentiometer pickoffs (center taps optional).
- **SIZE:** 1 7/16" dia., 3 1/4" long.
- **WEIGHT:** 1 lb.

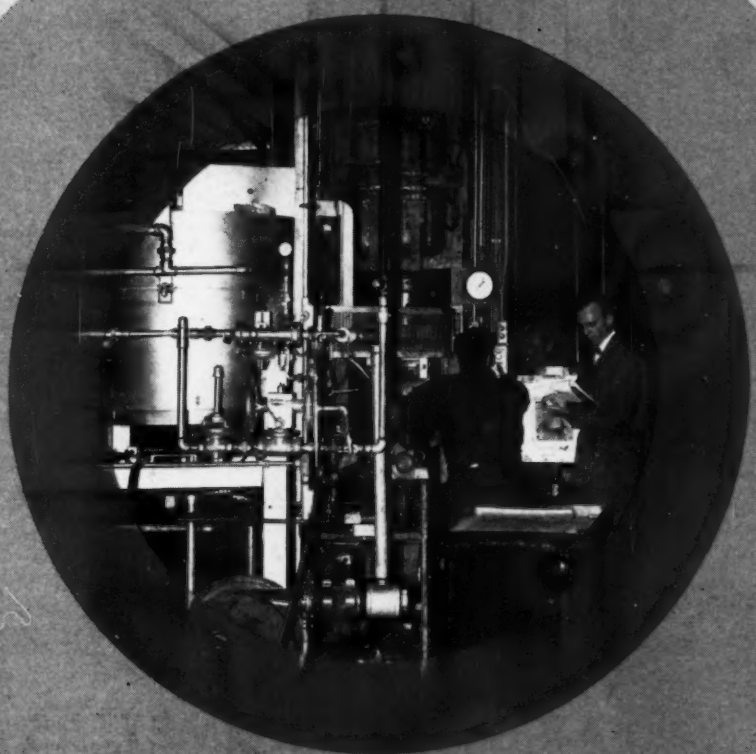
MINNEAPOLIS **Honeywell** H HONEYWELL

BOSTON DIVISION

THE TECHNOLOGY REVIEW, July, 1957, Vol. LIX, No. 9. Published monthly from November to July inclusive at Emmett Street, Bristol, Conn. Publication date: twenty-seventh of the month preceding date of issue. Annual subscription, $4.00; Canadian and Foreign subscription, $4.50. Entered as second-class matter December 23, 1949, at the Post Office, at Bristol, Conn., under the Act of March 3, 1879.

FUTURES

in NUCLEAR ENERGY...



Your future in nuclear fuel production can be realized by associating with the Nuclear Products Division of Metals & Controls Corporation — a company that maintains a continuing interest in the personal success of its employees and the undiminishing quality of its products.

We are growing to meet the expanding requirements for fuel elements and as an important part of this growth, we need bright, aggressive men. Experience in atomic energy is not required, but we do need scientifically trained people — people experienced in the mechanical, metallurgical or chemical fields.

Here are a few things you should know about us:

- Production of Nuclear Fuel Elements is our specialty.
- Nuclear Products Division has been able to translate scientific data and experimental results into production know-how and, utilizing this capability of scientific production, is establishing a leading position in the nuclear fuel element field.
- You will work in a stimulating atmosphere with the latest and most complete facilities yet developed.
- Nuclear Products Division is part of Metals & Controls Corporation, a company of 2500 people, small enough to insure individual recognition and growth — large enough to offer stability.
- We are located in Attleboro, Massachusetts — within easy commuting distance of Boston and Providence, offering exceptional cultural, educational and recreational facilities.

For details about joining this forward moving firm, write or call our Employment Director.

MIT ALUMNI

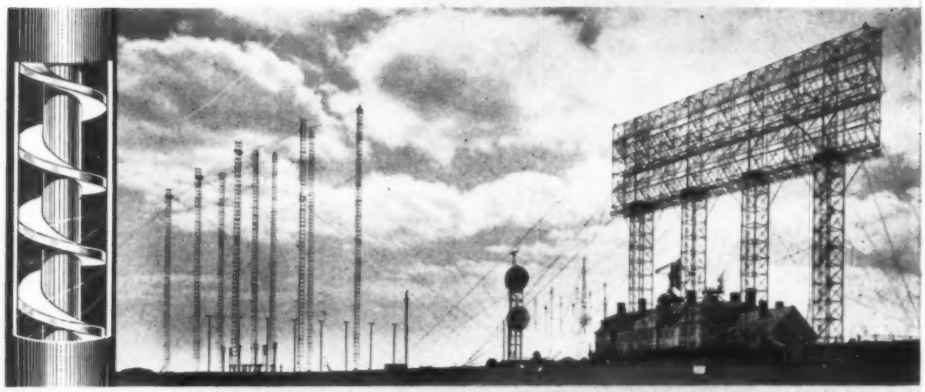
Robert Glidden	1926	Sidney Siegel	1943
Roger Hood	1945	Frederick Stearns	1946
Donald Hurter	1945	Graham Sterling	1949
Edward Jastram, Jr.	1935	George Williams	1939
Charles Patterson	1945	Carroll Wilson	1932
Robert Seavey	1942	John Wilson	1941

METALS & CONTROLS CORPORATION

Nuclear Products Division

1302 Forest St., Attleboro, Mass.
Telephone: Attleboro 1-2800

Demonstrating Outstanding Characteristics
for Forward Scatter Systems...



Round Hill Field Station, M.I.T.'s Lincoln Laboratories, South Dartmouth, Mass.

Styroflex Coaxial Cable

A recent series of experimental tests conducted by the Round Hill Field Station of M.I.T.'s Lincoln Laboratories at South Dartmouth, Mass., clearly showed that Styroflex coaxial cable has a number of practical advantages when used as the connecting link between the antenna and transmitter or receiver in forward scatter systems.

The tests demonstrated the particular importance of these general Styroflex characteristics:

1. 1000-foot continuous lengths without splices.
2. Low attenuation.
3. Excellent electrical properties.
4. Capacity to handle high power.
5. No age deterioration regardless of climatic conditions.

An additional advantage of Styroflex—when used as a receiving transmission line—is its extremely low inherent noise level.

Inquiries regarding specific applications for Styroflex are invited.

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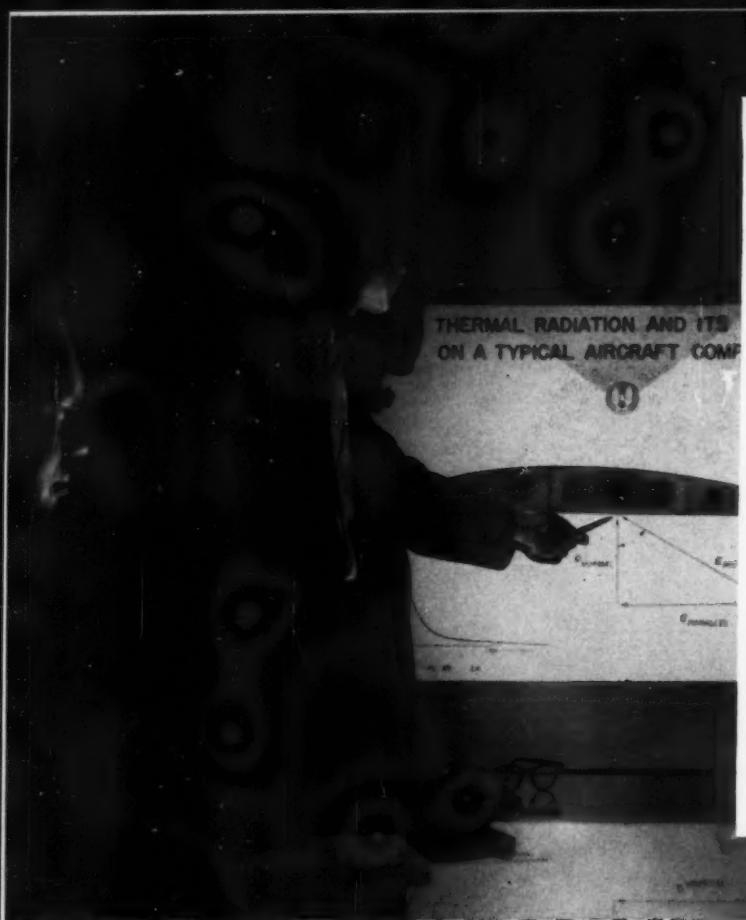

M.I.T. GRADUATES AT ALLIED RESEARCH

Name	Degree & Course	Year	Position
Lawrence Levy	SM, XVI	1948	President
Daniel J. Fink	SB, XVI	1948	Chief Engineer
	SM, XVI	1949	
Oiva R. Anderson	SB, XVI	1947	Senior Engineer
	SM, XVI	1948	
Martin Annis	SB, VI	1944	Chief Project Scientist
	PhD, VIII	1951	
Claude W. Brenner	SB, XVI	1947	Chief Project Engineer
	SM, XVI	1948	
Arthur B. Cicero	SB, II	1953	Staff Research Engineer
	SM, II	1954	
Carolus M. Cobb	SB, V	1944	Senior Chemist
	PhD, V	1951	
Richard E. Ellis	SB, VIII	1952	Research Physicist
Lawrence E. Golden	SB, XVI-A	1952	Staff Research Engineer
	SM, XVI	1953	
William D. Green, Jr.	SB, II	1943	Chief Project Engineer
	SM	1949	
David C. Knodel	SB, XVI	1947	Senior Engineer
	SM, XVI	1951	
Philip Marshall	SM, II	1955	Research Engineer
Roger W. Milligan	SB, XVI	1950	Research Engineer
Arthur C. S. Roberts	SB, XVI	1947	Senior Engineer
Leopold J. Rossbach	SB, VI-A	1950	Senior Electronic Engineer
	SM, VI-A	1951	
Melvin R. Rubin	SM, I	1951	Research Engineer
Richard Rubino	SB, XIV	1952	Personnel Manager
Charles M. Shure	SB, XVI	1957	Research Engineer
Calvin Y. Sing	SM, XVI	1954	Staff Research Engineer
Thomas B. Smith	SB, VI	1955	Research Engineer
John H. Stewart	SB, XVI	1953	Research Engineer
Robert A. Summers	SM, XVI	1946	Senior Engineer
	ScD, XVI	1954	

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This Delta Mount has been designed and tested to isolate airborne electronic equipment from severe environmental vibrations.

Plastic scintillators are easily machined and can be furnished in sizes up to one ton in varying shapes and surface textures.

FILLING A NEED...

ring the nineteenth century, the mechanics of fluids branched the main stem of physical science. Physics concentrated on the boration of the structure of molecules and their components; development of fluid mechanics was guided by the need for derstanding the macroscopic phenomena associated with ships, bines, airplanes, etc. The separation between these disciplines been reflected in the organization of university departments several generations, so that there is little contact between ysics and fluid mechanics departments. This lack of contact been reflected in our scientific graduates who typically have n trained in one or the other of these disciplines, but almost er in both.

ry suddenly, however, the country faced an important problem en we had to meet the challenge of rapidly creating an operable ercontinental ballistic missile. The re-entry of this missile into earth's atmosphere was regarded as a very difficult problem; ely because here, for the first time, we faced a scientific prob- involving the mechanics of a fluid closely coupled with im- tant aspects of molecular physics. The Avco Research Lab- tory was created to fill this need. Its senior scientific personnel re trained in classical aerodynamics, atomic physics, and ysical chemistry, and saw in this interdisciplinary area a unique portunity to broaden their background and to make creative ntributions in a field in which the great advances are still to made.

e laboratory has been successful in supplying vital information ich only a year ago was generally held to be obtainable only costly and time-consuming flight experiments. Our research ccess has resulted in a large development responsibility being trusted to this company.

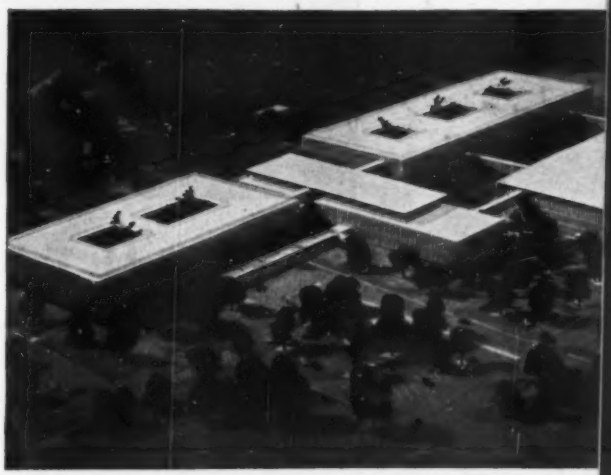
e interdisciplinary strength we have acquired will enable us to y a major role in such problems as the re-entry of manned hicles into the atmosphere from satellite orbits, in the creation a thermonuclear reactor, and in other fields involving the namics of high temperature gases.

Arthur Kantrowitz

Dr. Arthur Kantrowitz, Director
AVCO RESEARCH LABORATORY
a unit of the

avco | **research and advanced development division**

Dr. Arthur Kantrowitz



Pictured above is our new Research Center now under construction in Wilmington, Massachusetts. Scheduled for completion in early 1958, this ultra-modern laboratory will house the scientific and technical staff of the Avco Research and Advanced Development Division.

The Avco Research Laboratory at Everett, a unit of A.R.A.D., has a few openings for leading scientists who can help us expand our capabilities in:

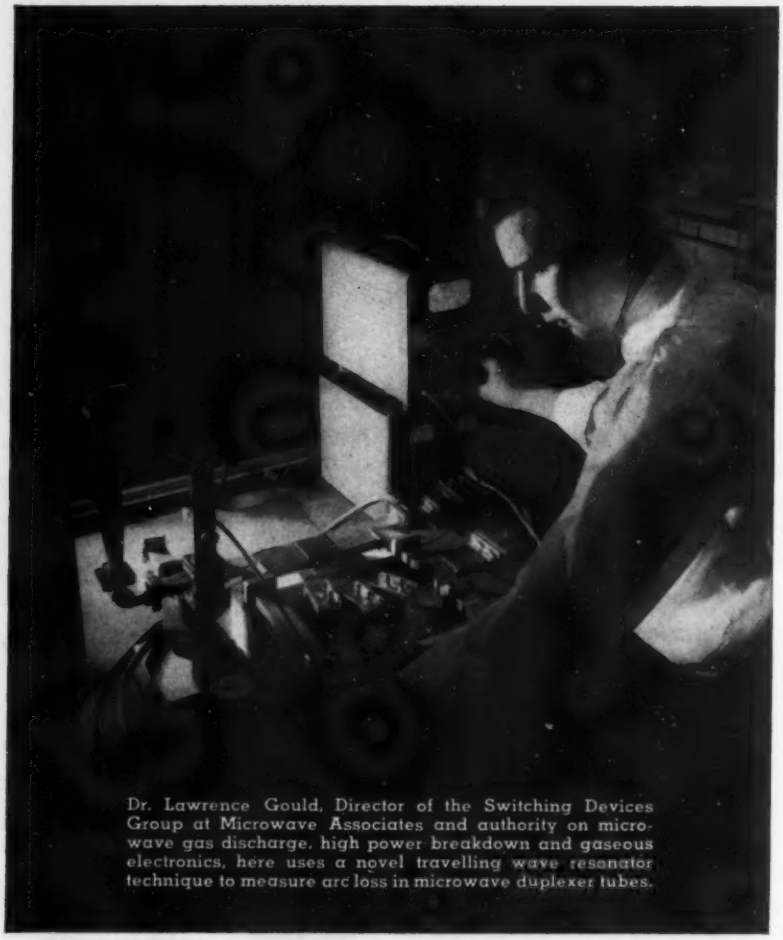
Theoretical, Experimental and Solid State Physics
Physical Chemistry—Aerodynamics—Physical Electronics

There are other career opportunities for exceptionally qualified scientists and engineers in the Development Laboratory at Lawrence and the Electronics Laboratory at Boston, in such fields as:

Science:
Physics—Mathematics—Metallurgy—Thermodynamics—Aerodynamics

Engineering:
Aeronautical—Chemical—Electrical—Mechanical

Write to Dr. R. W. Johnston, Scientific and Technical Relations, Avco Research and Advanced Development Division, 20 South Union Street, Lawrence, Massachusetts.



Dr. Lawrence Gould, Director of the Switching Devices Group at Microwave Associates and authority on microwave gas discharge, high power breakdown and gaseous electronics, here uses a novel travelling wave resonator technique to measure arc loss in microwave duplexer tubes.

You'll move ahead fast in electronics...

AT MICROWAVE ASSOCIATES, INC., progress in electronics is being accelerated every day by such fellow M. I. T. alumni as:

Apollo Cornelius Bougas	**– '57**
Willard Foster	**– '32**
Dr. Lawrence Gould	**– '50**
Daniel Lanciani	**– '48**
Frederick Parks	**– '34**
Julian Pathe	**– '48**
Allen Swartz	**– '50**
William Toorks	**– '36.**

So, you'll feel right at home when you join fast-growing MICROWAVE ASSOCIATES, INC. You may be assigned to Dr. Lawrence Gould's group . . . developing more effective TR switching tubes and duplexers having minimum arc loss, minimum recovery time and maximum band width . . . or you may direct your talents toward improving magnetrons, wave-guide components, silicon diodes, or other products.

You'll be happier and more secure at MICROWAVE ASSOCIATES, too. You'll soon be on a first-name basis with all 253 members of our small family . . . you're not just a number. And you'll enjoy all the advantages of big company stability. For, M-A is owned by American Broadcasting — Paramount Theatres, Inc., Western Union Telegraph Co. and the general public through Lehman Brothers Company.

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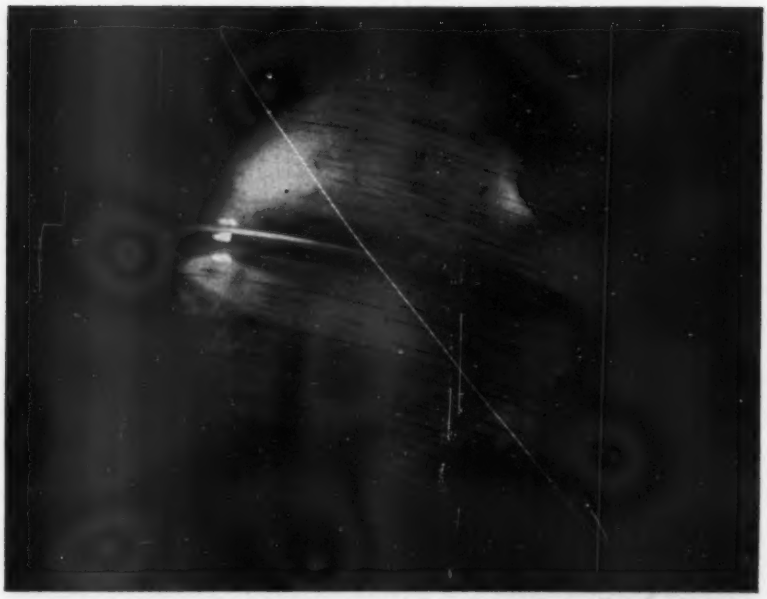

"AROUND THE WORLD IN 90 MINUTES"

The big show of 1958 will be watched by more people throughout the world than any other single event in history. For the coming Martin satellite program is the most dramatic engineering development of our time, and many of its most important supporting roles are in the basic field of servo engineering and instrumentation. If this is your kind of show, and you're interested in one of the great engineering opportunities of today and tomorrow, act fast...The count down has begun.

Contact J. J. Holley, Dept. TR-7, The Martin Company, Baltimore 3, Maryland.

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Nautilus

first
atomic submarine
uses

TIGER BRAND ELECTRICAL CABLE

The Nautilus was built by General Dynamic Corporation's Electric Boat Division shipyard, at Groton, Conn. She was launched on January 21, 1954.

We cannot recall a more *critical* application of electrical cable than this new atomic-powered submarine. And from stem to stern, this amazing ship is laced with Tiger Brand Electrical Cable.

Now hear this . . . YOU can get the same quality that went into the Nautilus.

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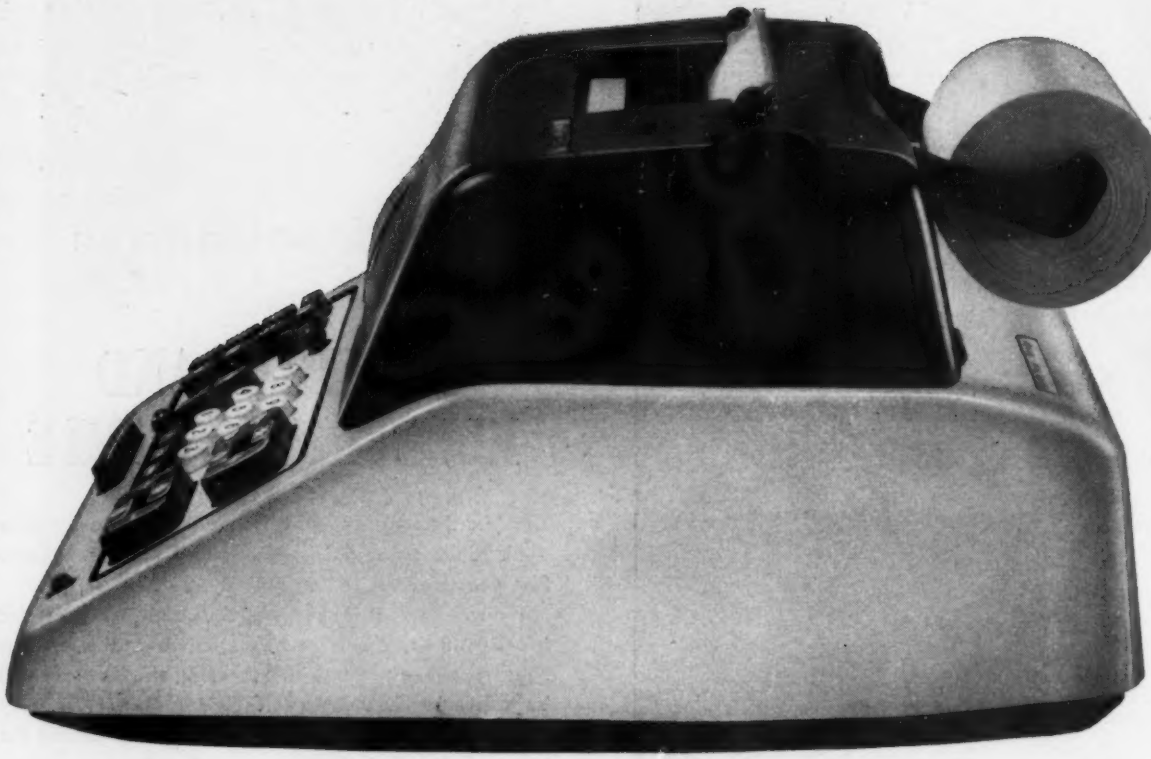


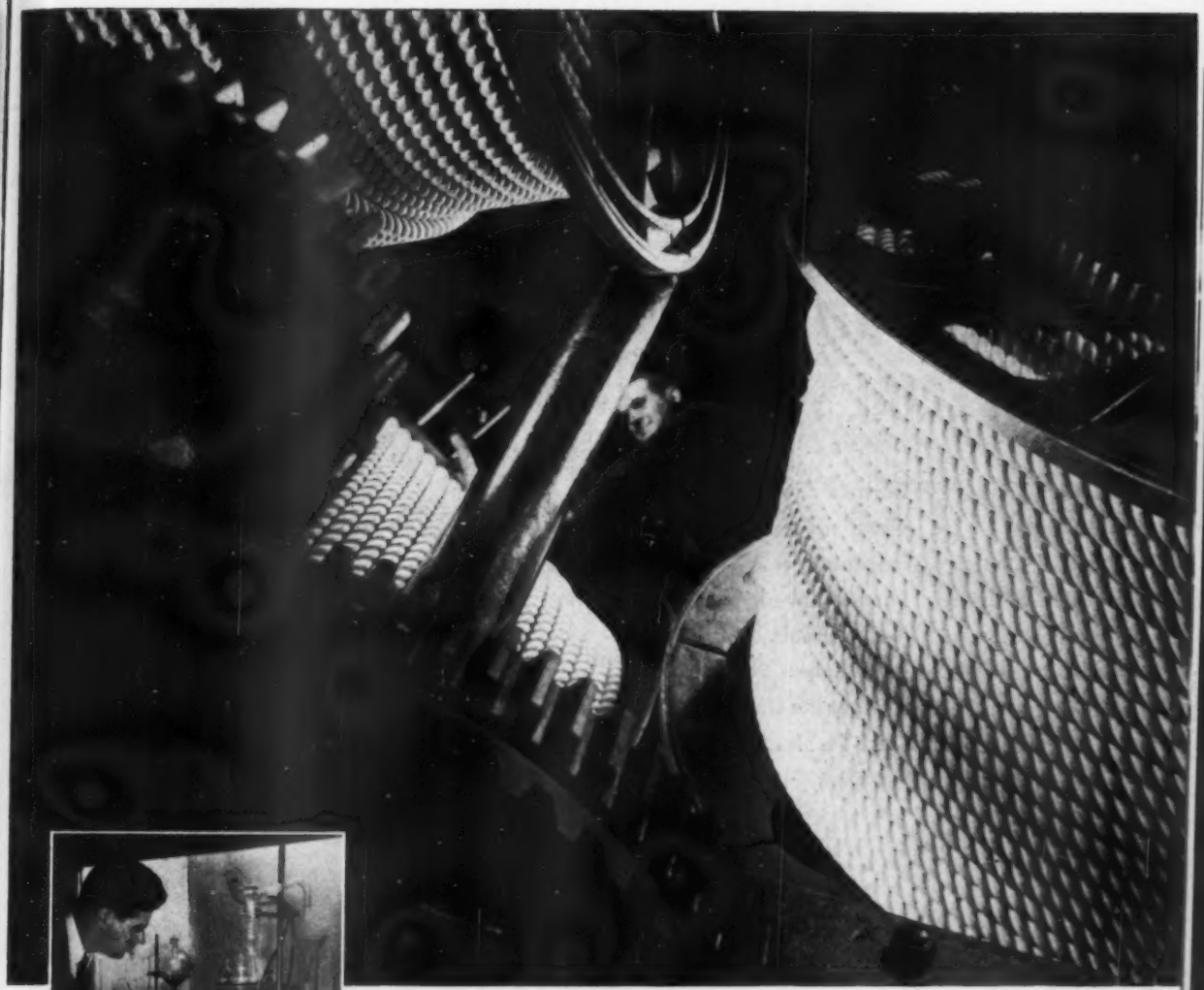
olivetti announces a new kind of desk calculator

The remarkable new Olivetti Tetractys processes business figures at high speeds formerly associated only with non-printing calculators, *and prints a complete tape record.* New in concept, new in range of application, it is the first (and only) dual-register printing calculator. It provides automatic accumulation, an automatic constant, and a "memory."

In combined operations, it eliminates the need to re-enter intermediate figures; these are *automatically* stored in the second register, or in the "memory." It automatically accumulates products, quotients and totals, to give a grand total. It can multiply a first number by a second number by a third number and so on, without re-entry of intermediate products. Its unique constant locks in and clears out automatically.

These features (plus others) enable the Tetractys to process many kinds of figurework faster than they have ever been done before. May we demonstrate this to you?

For a demonstration, or for more information, write or wire Olivetti Corporation of America, 580 Fifth Avenue, New York 36, N. Y. Olivetti sales and service available in all 48 states.



PLYMOUTH HAS THE ROPE KNOW-HOW YOU CAN USE IN INDUSTRY

Plymouth Cordage Company has the men, the equipment and the ability to produce the right rope for the most specialized job in industry.

Its ropes are engineered and manufactured to standards that provide more than adequate factors of safety.

You are invited to call upon us with your rope problem. Our long practical experience and research facilities are unsurpassed and may point the way to improved production and reduction of maintenance costs in your plant.

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Plymouth, Massachusetts

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Tool Steels	Electrical Alloys
Electrical Steels	Laminations
Extruded Shapes	Permanent Magnets
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Cast Cutting Alloys	High Speed Steels
Nitri-Cast Iron	Composite Die Sections

Tool Steel Cast-To-Shape

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Edward J. Hanley '24
R. M. Arnold '22
Victor Ardito '56
Dr. Henry L. Bishop '56
Henry M. Butler '50
James C. Fulton '53
Dr. Lawrence C. Hicks '39
Dr. P. K. Koh '39
Richard K. Pitler '49
Dr. Sundaresan Ramachandran '56
A. H. Riehl '41
Clifford J. Rounds '52
Bennett Sack '54
Richard P. Simmons '53

SD's

M.I.T. Graduates

F. Francis Birch, 1951

David Brown, 1940

John W. Colton, 1948

Robert S. Davis, 1955

Edward J. Fradkin, 1946

Manfred Gans, 1951

A. W. Gessner, 1954

Ralph Landau, 1941

John H. Lutz, 1943

George J. Marlowe, 1950

Robert H. Perry, 1951

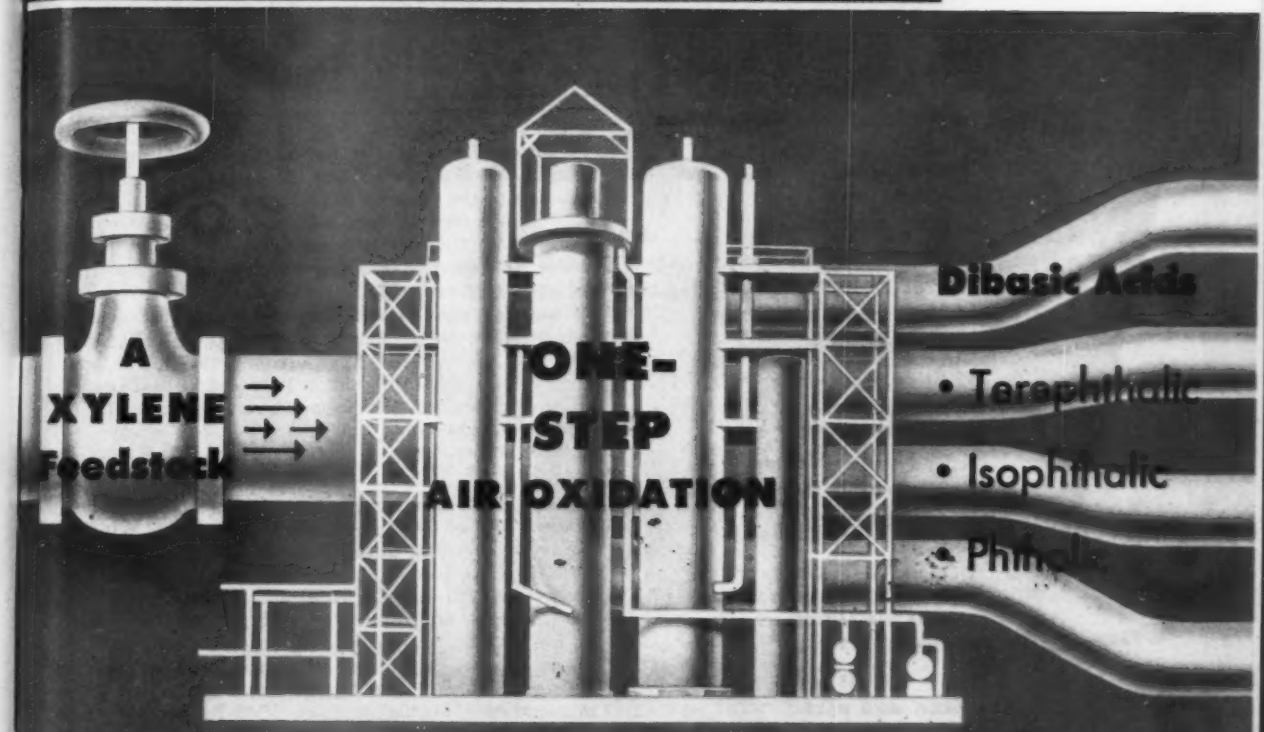
Max Sachs, 1946

Peter H. Spitz, 1949

Charles N. Winnick, 1948

SCIENTIFIC DESIGN COMPANY

AROMATIC CHEMICAL BREAKTHROUGH



According to Dr. Ralph Landau, Executive V.P. of SD, "Never before has a private engineering, research and design group created wholly by itself, with its own funds, such a major technical discovery and development in the chemical field. The sale of this process further confirms SD's position as the world's leading independent company devoted to process development and plant design in the organic chemical field. In only 10 years, SD has undertaken over forty different chemical plant projects, a greater number and diversity than those handled by all but the largest chemical operating companies."

SD Group Sells Exclusive Worldwide Rights to Standard Oil Company (Indiana)

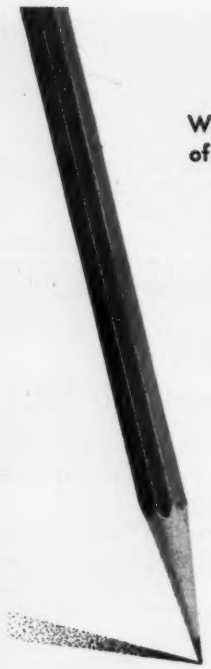
Having acquired exclusive worldwide rights, Standard decided to build a $10,000,000 plant based on this aromatic chemical breakthrough. SD is designing this plant for Indiana's subsidiary, Amoco Chemicals Corporation.

The successful conclusion of this project by SD and its associated companies is another example of SD's creative approach to many industrial chemical problems. In this case, Amoco's plant will have a new "production flexibility." One basic plant and equipment will produce a variety of chemicals from a variety of feedstocks. This is an almost complete answer to one of a chemical company's major problems — shifting markets and raw material sources.

If you are planning an expansion or diversification program in the field of organic chemicals, it will pay you to consult SD. Whether your project requires developing a new process, acquiring an existing process or engineering one of your own, you will profit by SD's confidential service. SD and its wholly owned construction subsidiary, SD Plants, Inc., will assume complete responsibility from earliest planning, through design and construction, to supervision of start-up and initial operation.

SCIENTIFIC DESIGN COMPANY, INC.
Chemical Processes • Plant Design • Construction
Executive Offices:
Two Park Avenue, New York 16, N. Y.

Engineering Offices:
Jersey City, New Jersey
Research Center:
Manorhaven, L. I., New York



N. B.

Write for the folder describing activities of The Lincoln Laboratory:

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DIGITAL COMPUTERS
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THE TABULAR VIEW

Stream of Life — In the Baccalaureate Address which GEORGE R. HARRISON, Dean of Science, delivered to members of the Class of 1957 (page 491), the graduates were admonished to seek security of spirit rather than peace of mind. In today's complex world, knowledge of science is regarded by Dean Harrison as an important factor in achieving this objective, as well as a necessity for any educated person. Stanford University awarded him the A.B., A.M. and Ph.D. degrees in 1919, 1920, and 1922 respectively. Dr. Harrison came to the Institute's Department of Physics in 1930 and in 1942 became Dean of the School of Science. He is best known for his work in spectroscopy, but is also an able speaker and brilliant author.

Equality and Excellence — This year's Commencement Address (page 495) was given by JOHN WILLIAM GARDNER, President of the Carnegie Corporation of New York, who received the A.B. degree from Stanford University in 1935 and the A.M. and Ph.D. degrees from the University of California in 1936 and 1938 respectively. He has been a professor of psychology, captain in the Marine Corps, and head of Latin-American Section, Foreign Broadcast Intelligence Service, Federal Communications Commission. Since 1946 he has been with the Carnegie Corporation of New York, becoming its president in 1955. Dr. Gardner's Commencement Address was concerned with educational facilities designed to maximize our national individual talents.

Knowledge Brings Obligation — The Farewell Address to this year's graduates (page 496) was given by Chancellor J. A. STRATTON who stressed the responsibilities which professional persons have to use their intellect and experience for advancing the common account. Chancellor Stratton received the S.B. and S.M. degrees from M.I.T. in 1923 and 1926 respectively, and the Sc.D. degree from the Eidgenossische Technische Hochschule in Zürich in 1927. He has also studied at Grenoble, Toulouse, Munich, and Leipzig. Dr. Stratton has been at M.I.T. since his appointment as assistant professor of electrical engineering in 1928. He was the first head of the Research Laboratory of Electronics, and the Institute's first Provost and also its first Chancellor, a post created in July, 1956. This June, he received an honorary LL.D. from Northeastern University.

Physical Sciences — JAMES B. FISK, '31, Executive Vice-president of the Bell Telephone Laboratories discussed progress in the physical sciences, especially in electronics and communications, at the Alumni Day Symposium on "Today's Science – Tomorrow's Promise" (page 497). He received the S.B. degree in aeronautical engineering and Ph.D. in physics from M.I.T. in 1931 and 1935 respectively and the M.A. degree from Harvard University in 1947. He was Proctor travelling fellow at Trinity College, Cambridge, a member of the Society of Fellows at Harvard, and has had extensive teaching and industrial affiliations in applied science, especially in the fields of electronics and nuclear science.

Science Education — JERROLD R. ZACHARIAS, Professor of Physics at the Institute spoke on science education at the Alumni Day Symposium (page 501). From Columbia

(Concluded on page 460)

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THE TABULAR VIEW

(Concluded from page 458)

University he received the B.A., M.A., and Ph.D. degrees in 1926, 1927, and 1933, respectively. Dr. Zacharias joined the Radiation Laboratory at M.I.T. in 1940 and has been associated with the Institute ever since, joining the Department of Physics in 1945. He organized and was head of the Laboratory for Nuclear Science until this year, and is now Chairman of the Physical Science Study Committee of the National Science Foundation.

Next Hundred Years — In his ninth annual report to Alumni (page 504), President JAMES R. KILLIAN, JR., '26, reviewed M.I.T. events of the past year, enumerated a ten-point program of objectives to be achieved as M.I.T. concludes its first century of operation, and announced the initiation of a fund to increase Faculty salaries. As usual, the President's annual report was an encouraging, stimulating, and forward-looking document well received by Alumni and friends of M.I.T. Dr. Killian is so well known to Alumni that a biography is unnecessary here. It is sufficient to mention that, among his most recent honors are the French Legion of Merit and the Public Welfare Medal of the National Academy of Science, both awarded within the past few months.

Cardinal and Gray — In addition to the signed feature articles enumerated above, The Review's running account of the year-end activities will be found beginning on page 507.

The Review is not published during the summer months following July. This issue, therefore, concludes Volume 59. Number 1 of Volume 60 will be published on October 28 and dated November. Readers who bind their copies are reminded that if they possess nine issues of Volume 59, their files are complete. An index to the volume will be ready on September 16 and will be supplied post free upon request.

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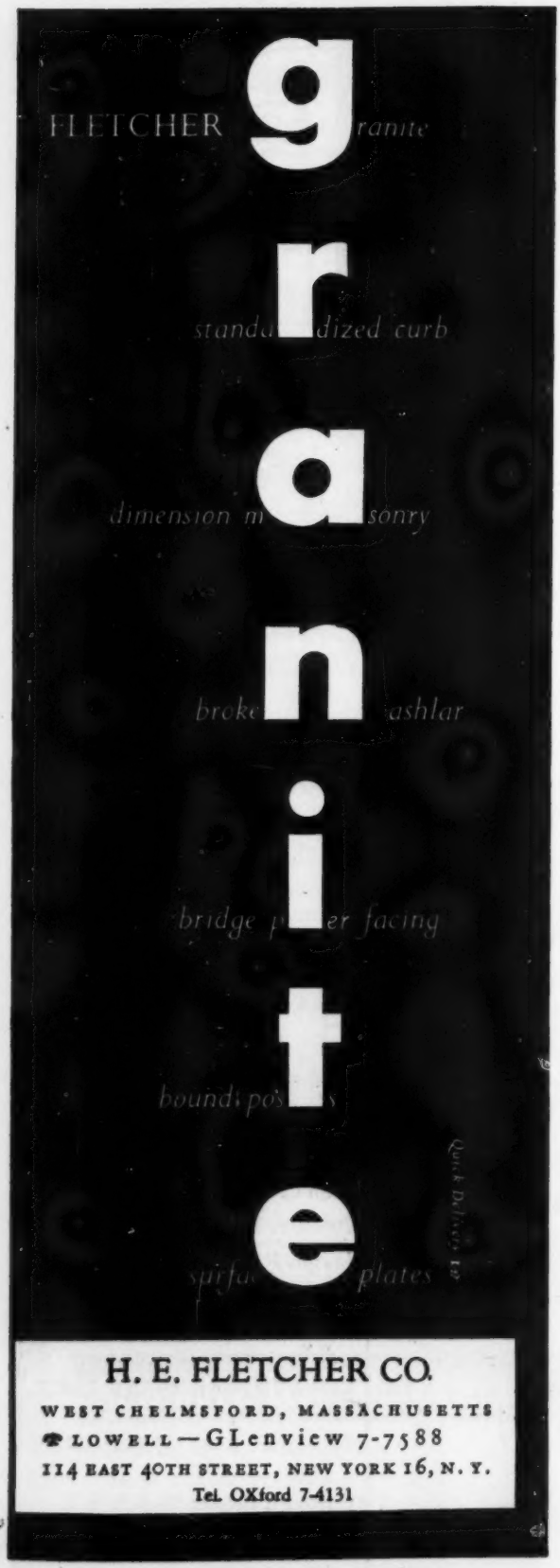

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The Taxpayer

Are high taxes reducing your incentive to work harder and earn more?

IF YOU'RE ONE of the more than 65 million Americans who hold down a job, you probably work about 40 hours a week.

But did you ever stop to consider that taxes are so high today you work for yourself only 27 of those 40 hours? The other 13 go to pay your share of the cost of government.

No one expects to live without taxes, obviously. But when they take more than $110 billion, or about one dollar out of every three earned, something's wrong.

You pay these taxes in more ways than you know, too.

If you lived in California, for instance, made $7,500 last year, and listed a wife and two children as dependents, you were taxed these ways to start with: Federal income $875, Social Security $95, State income $25, Property tax $325, Auto license tax $40, State and Local sales tax $75 and Telephone tax $10.

This adds up to $1445 and it's only the beginning.

Did you buy a car? Figure another $175 tax. The tax on the gasoline to run your car was at least $65. You also paid a 10% tax every time you bought a plane or train ticket or spent a dollar at the movies.

And you're still not through. Because every company that made anything you bought had to pay taxes on practically everything that went into the product.

These thousands of indirect taxes were eventually passed on to you as part of the cost of your purchases.

The result? At least one-third of what you earned went to pay taxes in one form or another.

The real danger is obvious: taxes this high may be so discouraging that you have less incentive to work harder, earn more money and produce more.

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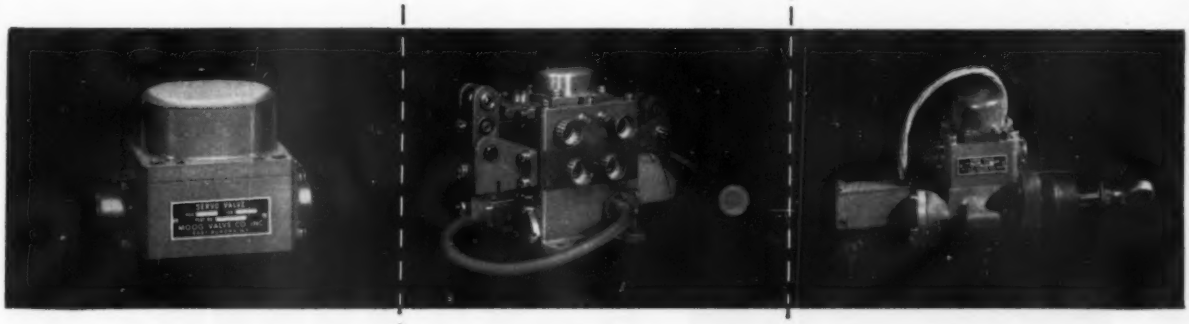

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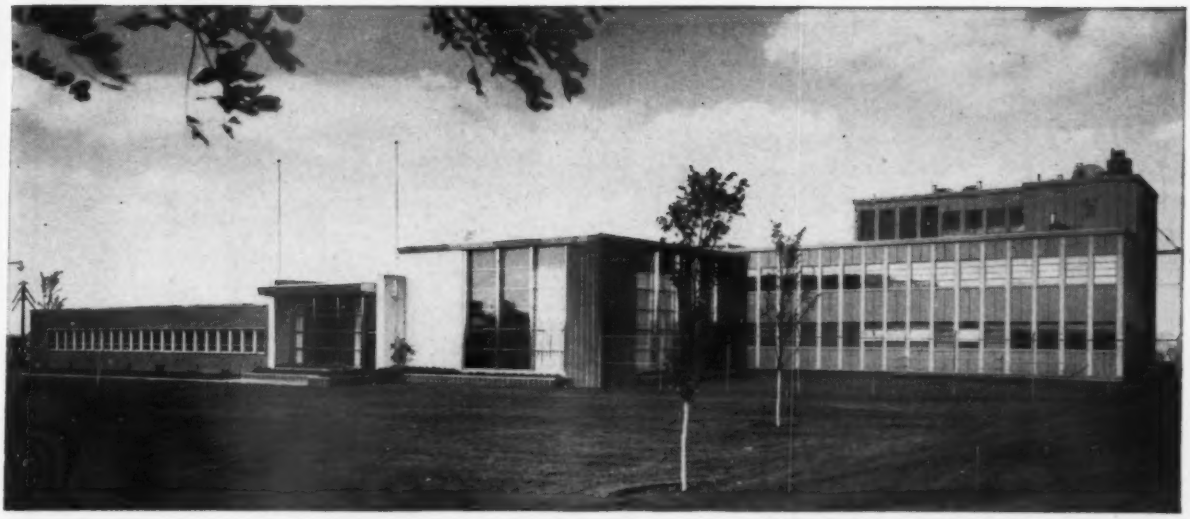

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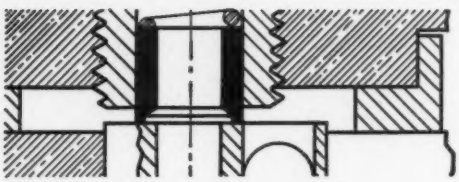

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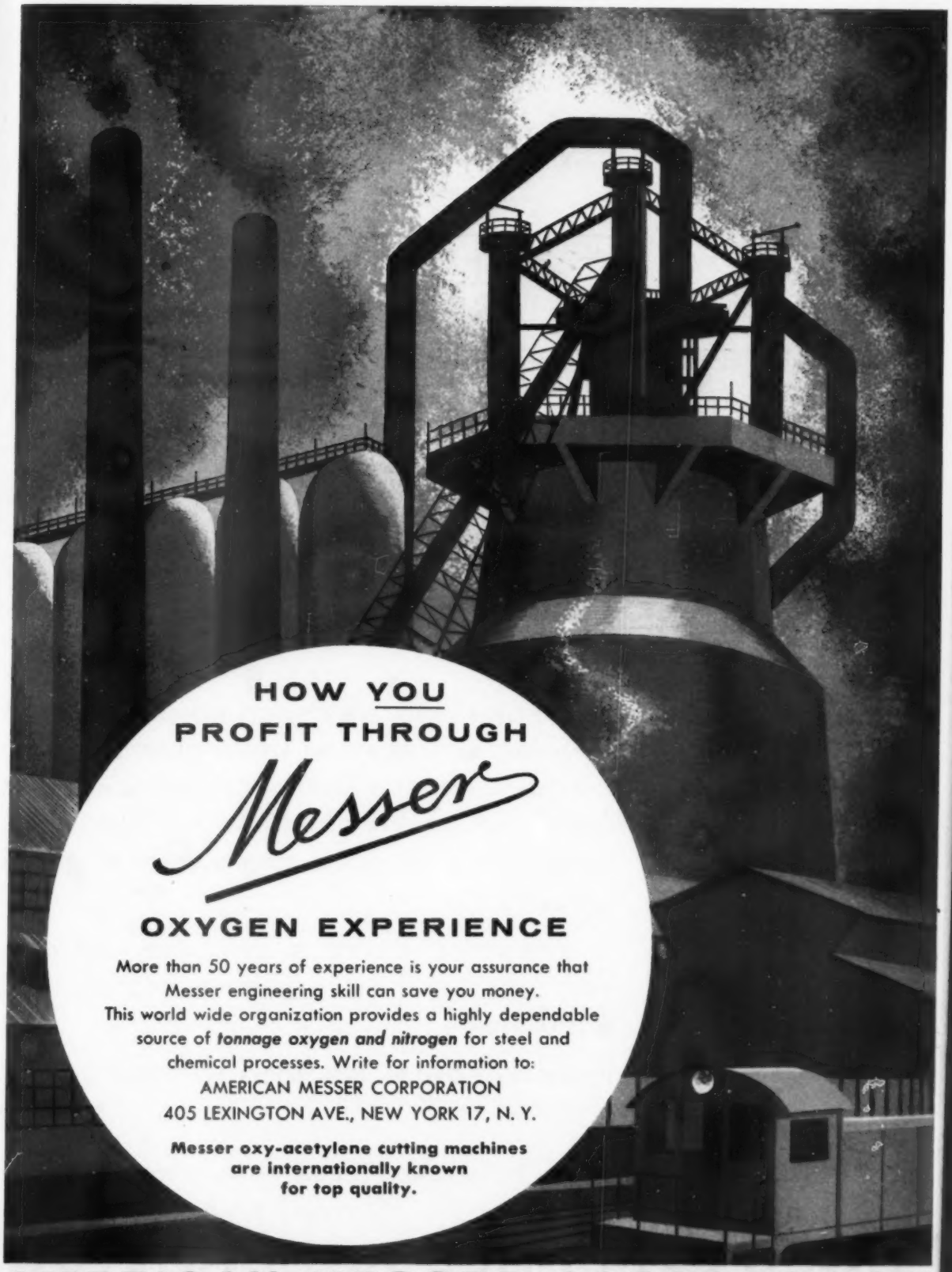
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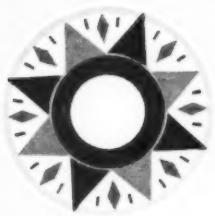

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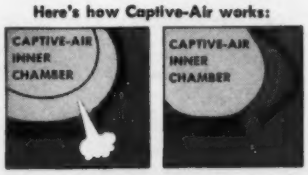

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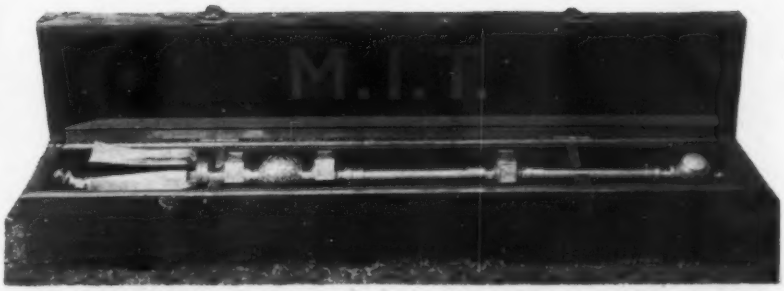

Mace, in black walnut case, made by Leverett Cutten, '07, and presented to the Institute upon the 50th anniversary of his class' graduation from M.I.T.

Technology Review

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Edited at the Massachusetts Institute of Technology

VOL. 59, NO. 9 JULY, 1957

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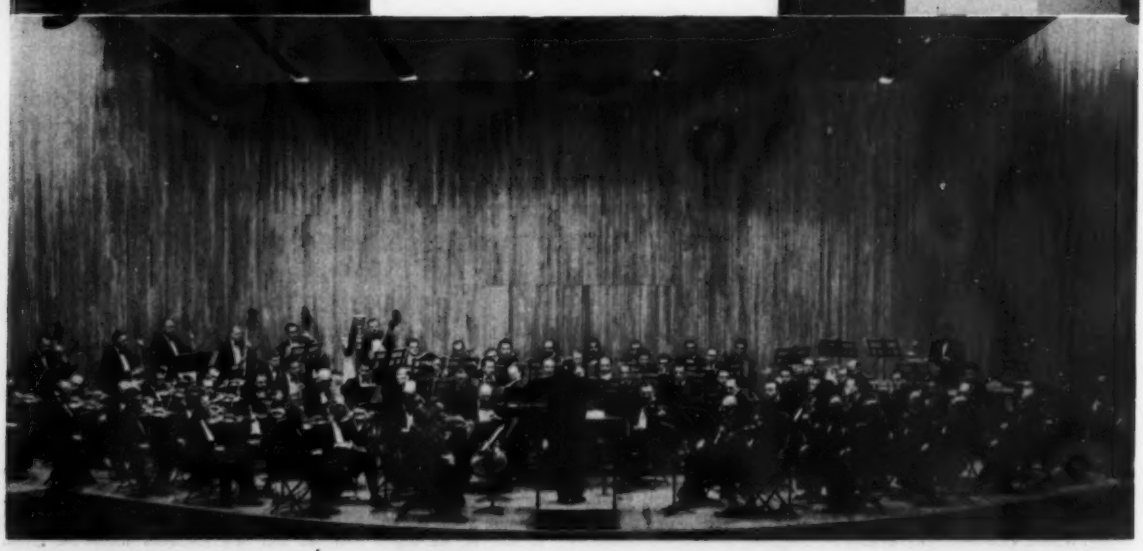

Signs of the Times

In clockwise order, beginning at upper left-hand corner, are these typical views of year-end events at M.I.T.: (1) Chancellor J. A. Stratton, '23; Rear Admiral John A. Snackenberg; Major General Edward H. Underhill; and Brigadier General Charles C. Calloway prior to commissioning exercises; (2) Fuhsi Tjian Ling, Marilyn Schranze, Emma M. Duchane, and Virginia D. Hermann, four of about a dozen women who received M.I.T. degrees in June; (3) As Commencement Day Marshal, Theodore T. Miller, '22, receives mace from Leverett H. Cutten, '07, for use in commencement procession; (4) Bryant Nichols, '07, and Thomas E. Sears, Jr., '32, watch as Gilbert M. Roddy, '31, adjourns Alumni Day banquet; (5) Arthur Fiedler conducting the Boston Pops Orchestra in Kresge Auditorium; (6) Joseph J. Snyder, '44, and John J. Desmond, Commissioner of Education for Massachusetts follow Walter Humphreys, '97, in commencement procession; (7) President Killian and Harold E. Edgerton, '27, examine time capsule prior to depositing it in concrete vault sunk in ground near entrance to Compton Laboratories.

The Technology Review

VOL. 59, NO. 9 JULY, 1957

The Trend of Affairs

Heads Industrial Relations

■ Major General James McCormack, Jr., '37, has been appointed Vice President for Industrial and Governmental Relations at the Institute, according to President Killian. He will succeed Vice Admiral Edward L. Cochrane, '20, who retired July 1.

General McCormack came to M.I.T. in 1955 as special adviser to the President after his retirement from the Air Force. Last year he also became president of the Institute for Defense Analyses, an agency established by M.I.T. and four other educational institutions to conduct scientific analysis work for the Department of Defense.

As vice president, General McCormack will represent the Institute in external relations with government and industry. He will have general supervision of policies of the Division of Sponsored Research, of Lincoln Laboratory in Lexington, the Instrumentation Laboratory in Cambridge and the Operations Evaluation Group in Washington.

General McCormack was born in Chatham, Louisiana, on November 8, 1910. He was graduated from West Point in 1932, was a Rhodes Scholar at Oxford University, receiving a B.A. degree in 1935, and took the degree of master of science in civil engineering at M.I.T. in 1937. During World War II, General McCormack served as a general staff officer in the War Department and with the 12th Army Group in Europe. After the war he was Director of Military Applications of the Atomic Energy Commission. His final military service was as Director of Research and Development of the Air Force.

James McCormack, Jr., '37

City Planning Head

■ John T. Howard, '35, one of the leading planning authorities in the country, has been appointed head of the Department of City and Regional Planning at the Institute, President Killian announced late in May. He has also been promoted from associate professor to full professor. As head of the department, Professor Howard will succeed Professor Frederick J. Adams, who will devote his full time to teaching.

Professors Adams and Howard are members of the firm of Adams, Howard, and Greeley, which has consulted on such assignments as the development of a metropolitan plan for the San Francisco Bay area and the planning of Ghandidham, new port city in India. The firm has been consultant for Boston, Worcester, Hartford, and many other cities in New England and other states.

During the past two years, Professor Howard has devoted much of his time to advising the National Capital Regional Planning Council in the development of a metropolitan plan for the 2,000-square-mile area around Washington, D.C.

Professor Adams joined the faculty of M.I.T. in 1932 and Professor Howard was one of his first students, receiving a degree of bachelor of architecture in city planning in 1935 and that of master in city planning in 1936. Professor Howard had studied at Antioch College and Yale University. He was planning director of Cleveland for seven years before returning to M.I.T.

He and Professor Adams each served two years as president of the American Institute of Planners.

John T. Howard, '35

Ralph Lowell, Trustee (left), congratulates Arthur L. Townsend, '13, who, as Director of Lowell Institute School, won the 1957 James H. McGraw Award for Technical Institutes.

Lowell Institute Events

■ Nearly 100 young men received certificates attesting to satisfactory completion of courses of study offered by the Lowell Institute School at graduation exercises held in Huntington Hall, M.I.T., on the evening of Thursday, May 23. Ralph Lowell, Trustee of the School and a member of the M.I.T. Corporation, presented certificates to members of the Class of 1957.

Arthur L. Townsend, '13, Director of the Lowell Institute School and Associate Professor of Mechanical Engineering at M.I.T., presided at the exercises and presented the students for their diplomas. Jacob P. Den Hartog, Head of the Department of Mechanical Engineering, spoke on behalf of M.I.T. under whose auspices L.I.S. courses of instruction are given.

The principal address of the 53d graduation exercises was given by Frederick W. Argue, Engineering Manager and Vice-president of the Stone and Webster Engineering Corporation. As one who has reached the top of the professional ladder and directs the work of a comprehensive engineering, design, and construction organization in the public utility field, Mr. Argue presented a brief but effective address on the value of continued study by those employed in industry.

John I. Dalco, engineer with the Stone and Webster Engineering Corporation and a member of the L.I.S. Class of 1922, presented the Charles Francis Park Medal to Herbert L. Lovejoy, Jr., this year's top-ranking graduate of the Lowell Institute School. Mr. Lovejoy completed studies in the electrical course and is employed by the Doelcam Division of the Minneapolis-Honeywell Regulator Company.

Graduation exercises were held on the 65th birthday of Arthur L. Townsend, who became professor emeritus on July 1. Although it could not be announced at the time, Professor Townsend had just been named to be recipient of the eighth annual James H. McGraw Technical Institutes Award as distinguished educator, administrator, and builder of young men. The award recognizes Professor Townsend's four decades of contributions to technical institute teaching, his skill as a teacher, and his championing of high standards in technical education. Presentation was made at the annual meeting of the American Society for Engineering Education, held at Cornell University on June 18. The award is named in honor of the founder of the McGraw-Hill Book Company, and is made on the basis of achievements in technical education, administration, and contributions to technical literature.

Murray P. Horwood: 1892–1957

■ Murray Philip Horwood, Professor of Sanitary Science and Director of Sanitation at M.I.T., died in Providence, Rhode Island, on June 4. He was 64 years old.

A native of New York, Professor Horwood was a graduate of the College of the City of New York. He received the M.S. degree from M.I.T. in 1916 and in that year joined the staff as an assistant in biology. In 1921 he was awarded a Ph.D., specializing in bacteriology, sanitation, public health and sanitary enginering. While on the staff of M.I.T., he had also been an instructor at Wellesley College and had been in charge of public health at Boston University Medical School and Tufts Medical School. He became Professor of Bacteriology and Municipal Sanitation in 1937 and Professor of Sanitary Science in 1944.

Professor Horwood was widely active as a consultant to municipalities and companies on problems of public health and sanitation and was the author of several books and more than seventy papers in those fields. From 1952 to 1954, he was Director of the M.I.T. Educational Project at the Engineering College of the University of Rangoon and conducted several health studies in Burma. At the time that he was fatally stricken he was engaged in a health survey in Bristol, R.I.

Penicillin and Metallurgy

■ Modern progress in synthesizing penicillin and in developing new metals for current technological needs were topics of discussion at the 325th meeting of the Alumni Council, at which Theodore T. Miller, '22, President of the Alumni Association, presided. The meeting, held at the Faculty Club on April 29, was attended by 131 members and guests.

As secretary of the Alumni Association, Donald P. Severance, '38, reported that, between April 23 and May 27, ten M.I.T. clubs had been visited by 13 members of the staff. Oscar H. Horovitz, '22, visited the M.I.T. Club of Hong Kong on April 23 and the M.I.T. Club of Tokyo on May 10; all other visits were to clubs in continental United States. Mr. Severance also announced that the second Alumni Officers' Conference will be held at M.I.T. in September.

As director of the Alumni Fund, Henry B. Kane, '24, reported that, as of May 27, the Alumni Fund for the current year stood at $495,328 with 11,519 contributors. This is approximately $20,000 ahead of the figure at the corresponding date in 1956, and there are 1,570 more contributors than last year. Much of the increase in participation is due to the fine efforts of 73 Regional Committees working under the inspiration of Joseph E. Conrad, Regional Fund Director. The region of Kalamazoo has joined the Alumni Council in having 100 per cent of its members

participate in the Fund. According to a tabulation released by the American Alumni Council, M.I.T. was ninth among more that 400 American colleges in Alumni Fund contributions last year, and that in total alumni giving, M.I.T. stood fourth; only Yale, Harvard, and Chicago alumni made a better showing.

As chairman of the Committee on Honorary Members, Samuel C. Prescott, '94, proposed the name of Miss Olive Barnard, Secretary and Technical Assistant in the Department of Business and Engineering Administration, for honorary membership in the Alumni Association. Dr. Prescott's report was accepted with enthusiastic applause.

As executive vice-president of the Alumni Association, H. E. Lobdell, '17, reported on progress which the Alumni Association had achieved during the past year. The ninth and tenth Regional Conferences, in Tulsa, Okla., on February 2, and in Chicago on February 16, were pronounced eminently successful. So, too, were the "M.I.T. Week End in Havana" (February 22-25) and the Ninth Annual Fiesta (March 14-16) staged by the M.I.T. Clubs in Havana and in México City, respectively. Also singled out for mention was the dinner in New York on November 14, 1956, at which honor was paid to a distinguished Alumnus — Alfred P. Sloan, Jr., '95. Mr. Lobdell's annual report also contained significant statistics regarding the age distribution of the members of the Alumni Association.

Upon conclusion of the business portion of the meeting, John C. Sheehan, Professor of Organic Chemistry, spoke on the first successful synthesis of penicillin, tracing the history of the development of penicillin to Fleming's chance observation in 1928. During World War II, at least 1,000 chemists, working in 39 laboratories in the United States and Great Britain, spent an estimated $20,000,000 trying to synthesize penicillin in a crash program. Although they failed in their immediate objective, much was learned about the structure of the penicillins and of many approaches which could not be used to synthesize this molecule.

The penicillin molecule is not an unusually complex one. Similar molecules, such as those of quinine, morphine, and cortisone had yielded to synthesis. But the penicillin molecule is unstable and disintegrates easily — especially at one point in the process.

Ten new kinds of the synthetic penicillin are now being tested for possible medical use. These types are all antibiologically active and could not have been obtained through the fermentation process. While the new chemical method probably will not be cheap enough to compete with the established fermentation process by which penicillin is derived from molds, it is hoped that the new forms will prove effective against disease organisms now resistant to natural penicillin and against a wider variety of infections. New penicillins might also have less tendency to produce allergic reactions. Incidentally, since the cost of manufacturing, in bulk, a life-saving dose of such antibiotics is in the range of five cents by current fermentation process to 25 cents for new organic or new synthesized penicillins, the higher manufacturing cost of these new organic chemicals is small compared to cost of distribution and need not be a significant deterrent to their use.

On the Horizon

September 6–7, 1957 — 2d Alumni Officers' Conference, M.I.T. Campus in Cambridge.

December 7, 1957 — 11th M.I.T. Alumni Regional Conference, Pittsburgh, Pa.

Final speaker of the evening was Morris Cohen, '33, Professor of Physical Metallurgy, who spoke on "A Glimpse at Modern Metallurgy." Professor Cohen reminded his audience that out of the remarkable developments of gas turbines, jet engines, and nuclear reactors has come a new technological bottleneck. An important need to be fulfilled in achieving additional progress is to determine how and where new materials, capable of withstanding extreme conditions of stress, temperature, corrosion, and ability to withstand nuclear radiation, can be developed. Opportunities in metallurgy and the demand for metallurgists have never been so great and varied as today.

There is a growing awareness throughout the leading nations of the world that handbook information on conventional materials is no longer adequate for the needs of modern technology. To meet this challenge, metallurgists are probing more deeply into the basic nature of metals and are boldly developing new alloys from substances that were only curiosities in the periodic system a decade ago. Metallurgy today is closely related to physics, chemistry, mechanical engineering, and chemical engineering.

There has been an accelerating trend toward higher operating temperatures. In the generation of steam power, for example, during the past 50 years the operating temperature has increased from about 500 degrees F. to 1,050 degrees F. This has been made possible by improvements in steel through alloying molybdenum and other metals. Steam pressures have increased accordingly. In 1940 gas turbines and jet engines operated at temperatures of 1,200 degrees F. In 1956 operating temperatures were about 1,550 degrees F. with far greater thrust as a result.

Fracture due to brittleness is another one of the problems to which the metallurgist devotes much effort. During World War II some welded tankers and freighters actually broke in two and at least 1,000 underwent a major failure of some sort because of brittleness and fatigue.

Theoretically, one should readily obtain steels with a tensile strength of 1,000,000 pounds per square inch. Because of the presence of impurities and irregular crystal structure, actual metals usually yield strengths of about one per cent of their theoretical value. Dr. Cohen described briefly some of the reasons for this discrepancy and described how pure whiskers or filaments 10^{-4} centimeter diameter will exhibit tensile strength of 500,000 pounds per square inch — or within a factor of two of the theoretical value.

Following an extended question period the meeting was adjourned at 9:30 P.M.

Individuals Noteworthy

■ Prominent in the news since The Review's last issue have been the 30 Alumni promotions, elections, or appointments enumerated below:

Homer N. Calver, '14, as Visiting Professor in Public Health, American University of Beirut, Lebanon . . . *Elmer E. Dawson, Jr., '14,* as a Director, Compo Shoe Machinery Company;

Everett S. Coldwell, '15, as Chairman of Ford, Bacon, and Davis . . . *Marshall B. Dalton, '15,* and *Hovey T. Freeman, '16,* respectively, as a Director and the Secretary of the National Fire Protection Association;

Willard C. Brown, '16, and *Roscoe H. Smith, '23,* respectively, as President and First Vice-president of the Cleveland Engineering Society . . . *Timothy E. Shea, '19,* as Vice-president, Engineering, Western Electric Company;

J. Rowland Hotchkin, '21, as a Director, United-Carr Fastener Company . . . *Francis J. Magee, '21,* as Assistant Chief Engineer for Construction and Design, Mass. Department of Public Works;

Charles W. Maloney, '21, as Chief Electrical Engineer, Stone and Webster Engineering Corporation . . . *John J. Cychol, '22,* as Chief Engineer of the 5th District, Illinois, Division of Highways;

James F. Crist, '24, as President, Southern Electric Generating Company . . . *Dean E. Hutchisson, '24,* as Director of the American Institute of Physics;

James A. Drain, Jr., '26, as Vice-president, Mining and Construction Division, Joy Manufacturing Company . . . *Philip W. Robinson, '26,* as Plant Superintendent, Latchford-Marble Glass Company, Los Angeles;

Brigadier-General Ernest K. Warburton, '26, as Commanding General of the Operational Test Center, Eglin Air Force Base, Florida . . . *Fermo A. Bianchi, '27,* as President, New England Road Builders' Association;

Howard A. Chinn, '27, as Chief Engineer, CBS-TV . . . *Royal Weller, '27,* as Vice-president in charge of engineering, Stromberg-Carlson Division, General Dynamics Corporation . . . *Donald W. Fetters, '32,* as President, Gerhardt F. Meyne Company, Chicago;

Samuel A. Groves, '34, as President, United-Carr Fastener Corporation . . . *James H. Kimberly, '34,* as President, International Cellucotton Products Company, Chicago . . . *Lawrence C. Hall, '35,* as Vice-president of the New Hampshire and Granite State Fire Insurance Companies.

George E. Valley, Jr., '35, as Chief Scientist, U.S. Air Force, succeeding *Courtland D. Perkins, '41* . . . *Norman T. Robey, '36,* as Assistant Manager, Whiting Refinery, Standard Oil Company of Indiana . . . *Gouq-Jen Su, '37,* as Professor of Chemical Engineering, University of Rochester;

Richard T. Orth, '40, as Vice-president and General Manager, Electronic Tube Division, Westinghouse Electric Corporation . . . *David R. Herwitz, '46,* as Professor of Law, Harvard Law School . . . *Phillip H. Smith, '52,* as Director of Purchases, La Salle Steel Company, Chicago.

■ Special honors recently announced or awarded to Alumni and members of the Faculty included:

To *Jerome C. Hunsaker, '12,* its Gold Medal, by the Royal Aeronautical Society of Great Britain . . . to *George A. Richter, '13,* an honorary doctorate of technology, by the University of Göteborg, Sweden;

To *Howard L. King, '15,* named "Metropolitan Civil Engineer of the Year," by the Metropolitan Section of the American Society of Civil Engineers . . . to *Joseph W. Barker, '16,* an honorary doctorate of engineering, by Rose Polytechnic Institute . . . to *Lawrence H. Flett, '18,* honorary life membership, by the American Institute of Chemists;

To *James R. Killian, Jr., '26,* decorated as an Officer of the Legion of Honor, by France; and its Public Welfare Medal, by the National Academy of Sciences . . . to *Louise Hall, '30,* the Founders Fellowship Award, by the American Association of University Women;

To *Harry M. Krutter, '32,* the Distinguished Civilian Service Award, by the United States Secretary of Defense . . . to *Chandler Wentworth, '35,* a "major award" in the 1957 Design Competition, sponsored by *Materials and Methods* magazine . . . to *Walter S. Pierce, '47,* First Award in the "Homes for Better Living" contest, sponsored by the American Institute of Architects, *House and Home, Better Homes and Gardens,* and National Broadcasting Company;

To Professors *Charles S. Draper, '26,* of Aeronautical Engineering; *John C. Sheehan,* of Organic Chemistry; and *Jerrold R. Zacharias,* of Physics, election to membership in the National Academy of Sciences.

■ Kudos came to 14 Alumni last May upon the occasion of its 100th anniversary celebration in Washington by the American Institute of Architects. As previously announced in The Review (March, 1957, page 244), *Ralph T. Walker, '11,* and *Louis H. Skidmore, '23,* respectively, received the Centennial Gold Medal and the annually awarded Gold Medal.

Of the 48 named for 1957 to the College of Fellows, a body composed of less than 4 per cent of the Institute's total membership of over 11,000, five were Alumni, namely: *B. Sumner Gruzen, '26, Joseph D. Murphy, '29, Fred L. Markham, '30, Benjamin L. Smith, '30,* and *Thomas K. FitzPatrick, '32.*

From 344 "submissions" for judgment at the centennial celebration, six were chosen to receive "First Honor Awards," and 14 others to receive "Awards of Merit."

Of the six "First Honor Awards," two were shared by *Herbert L. Beckwith, '26, Lawrence B. Anderson, '30, William E. Haible, '39,* and *William W. Caudill, '47.*

Of the 14 "Awards of Merit," three were shared by *Edward A. Merrill, '22, Walter T. Rolfe, '23, Louis H. Skidmore, '23, Albert S. Goleman, '25,* and *William W. Caudill, '47.*

■ Among the Alumni to whom birthday congratulations are appropriate during the summer are seven due to celebrate 90th anniversaries, and 19 their 80th, as listed below with dates of birth:

July, 1867 — *Charles G. Trefethen, '88,* on the 4th; *Albert C. Smith, '96,* on the 22d; and *Ralph Sweetland, '88,* on the 28th;

August, 1867 – *Charles G. Merrell,* '88, on the 2d; and *Frank E. Newman,* '92, on the 13th;

September, 1867 – *Miss Lucy Walker,* '89, on the 1st; and *J. Vaughan Dennett,* '93, on the 27th;

July, 1877 – *Edward E. Albee,* '99, on the 8th; *Harry M. Thayer,* '00, on the 10th; *George H. Archibald,* '00, on the 22d; *M. DeKay Thompson,* '98, and *John W. Brown,* '00, on the 23d;

August, 1877 – *Miles S. Sherrill,* '99, on the 2d; *Arthur F. Brewer,* '99, on the 7th; *George T. Cottle,* '98, and *C. Gardner Barry,* '99, on the 10th; *Kenneth M. Blake,* '99, on the 13th; *Mrs. Marion L. Woodman,* '00, on the 15th; *Charles E. Smith,* '00, on the 20th; and *Kenneth Seaver,* '00, on the 26th;

September, 1877 – *Robert S. Blair,* '00, on the 1st; *Charles H. Hughes,* '00, on the 3d; *James G. MacDonald,* '00, on the 7th; *Francis C. Lincoln,* '00, on the 8th; *Mrs. Helen M. Hill,* '99, on the 18th; and *Edgar P. Trask,* '99, on the 28th.

With these 26, the rolls of the Alumni Association will include a total of 59 living nonagenarians and 598 octogenarians.

Visiting Committee Report on Chemical Engineering

■ All members of the Visiting Committee on the Department of Chemical Engineering, except Bradley Dewey, '09, and David W. Harris, met with C. Richard Soderberg, '20, Dean of the School of Engineering, Robert M. Kimball, '33, Secretary of the Institute, and members of the Faculty of Course X on May 14, 1956.* Mimeographed material had been distributed to members of the Committee in advance, so that members could proceed directly to a discussion of pertinent issues.

A wide range of topics was discussed by the Visiting Committee under the general headings of Department Status, Nuclear Engineering, and General Policy. The details of the Committee's examination are too long to be given here, even in condensed form. However, the summary of the Executive Session of this Committee's deliberations will indicate the general areas examined and will also indicate the recommendations which the Committee made.

The Committee notes with satisfaction the improvements made at M.I.T. during the year in staff salaries and pension benefits. It regards it as urgently necessary to continue the efforts to increase the incentive for outstanding scientists and engineers to remain in teaching.

It is realized that during the coming years M.I.T. will face strong pressures for expansion both on the undergraduate and graduate levels. The Committee urges that, in approaching this problem, M.I.T. keep in mind that it can serve the nation most effectively by maintaining its high standards, and realizes that rigid plans in this respect cannot be made for long periods ahead.

Because of the increased complexity and changed emphasis of the chemical engineering field, the Committee recommends that the Institute's Department of Chemical Engineering plan for increased activity at the doctoral level but retain its emphasis on the M.S. degree. This will require an increase in the Department's research program, as well as an increase in the available fellowships for graduate students.

The Committee notes with interest the increased attention now given to the problem of automatic control for chemical engineering plants. It urges that the Department seize the initiative in this problem in co-operation with other departments which can provide specialized assistance.

The Committee recommends that the Department give careful attention to its role in applied science in relation to chemical engineering. The Department's leadership in the past must be maintained, but modern conditions require that it be broadened to include physical, as well as chemical, phases of applied science.

In view of the satisfactory status of the Department, as a whole, the Visiting Committee recommends that, the major effort for future meetings be devoted to detailed and searching discussions of specific problems which call for study. The specific problems which the Committee has in mind at the present time are: (a) the Program of Undergraduate Teaching in Chemical Engineering; (b) the Program of Applied Chemistry and Physics in Chemical Engineering; (c) the Role of Creative Thinking in Chemical Engineering; (d) the Departmental Structure in Engineering at M.I.T.

The Department may have other topics which it might wish to add to this list. In order to make the discussion as effective as possible, the Committee recommends that the major points of the issues selected for the next meeting be brought out in a short report in advance of the meeting, the report to be used as a guide for the discussion.

After review by the Institute's Executive Committee in August, and by the Corporation on October 1, 1956, the report of the Visiting Committee was submitted for publication in The Review on October 25, 1956.

David L. Eynon

At 60th anniversary celebration of M.I.T. Club of Philadelphia at Longwood Gardens, estate of the late Pierre S. du Pont, '90, Samuel K. McCauley, '41, President, presents honorary life membership to Greville Haslam, '15, as David A. Shepard, '26, Theodore T. Miller, '22, and Herbert R. Moody, '41 (left to right), approve.

* Members of this Committee for 1955-1956 were: Charles A. Thomas, '24, chairman, Bradley Dewey, '09, Fred C. Koch, '22, William S. Brackett, '23, Marion W. Boyer, '25, Clarence L. A. Wynd, '27, Robert Cairns, David W. Harris, and Henry D. Smyth.

Twenty-five Years Ago This Month . . .

■ On July 1, 1932, Bradley Dewey, '09, President of the Dewey and Almy Chemical Company, retired as the 38th President of the Alumni Association, being succeeded in that office by Allan Winter Rowe, '01, Chief of Research Service of the Evans Memorial of the Massachusetts Memorial Hospitals. Other retiring officers of the Dewey Administration of 1931-1932 were: Donald G. Robbins, '07, as Vice-president; Henry E. Worcester, '97, and Raymond Stevens, '17, as members of the Executive Committee. Their respective successors in the Rowe Administration of 1932-1933 became: Harrison P. Eddy, Jr., '17, C. Adrian Sawyer, Jr., '02, and Marshall B. Dalton, '15.

[Five of the above-mentioned subsequently served as Presidents of the Alumni Association, namely: Robbins, 43d President in 1936-1937; Dalton, 44th in 1937-1938; Worcester, 47th in 1940-1941; Stevens, 51st in 1944-1945; and Sawyer, 56th in 1949-1950.]

. . . William Z. Ripley, '90, Elisha Lee, '92, and Roger W. Babson, '98, retired as Alumni Term Members of the Institute Corporation, being succeeded by Bradley Dewey, '09, M. Herbert Eisenhart, '07, and Jerome C. Hunsaker, '12.

[Later, Mr. Dewey was elected a Life Member of the Corporation from which body Dr. Hunsaker resigned his Term Membership to become a member of the Faculty and Head of the Departments of Mechanical Engineering (1933-1947) and Aeronautical Engineering (1933-1952).]

. . . Faculty retirements for the year ending June 30, 1932, were: Professors Frank A. Laws, '89, of Electrical Measurements; Arthur G. Robbins, '86, of Topographical Enginering; and Robert H. Smith of Machine Construction; and Assistant Professor James R. Lambirth of Mechanical Engineering.

Allan Winter Rowe, '01, and Karl Taylor Compton

Visiting Committee Report on Electrical Engineering

■ The Visiting Committee on the Department of Electrical Engineering* met on October 1 and 2, 1956, with the following members present: Max I. Alimansky, '28, George W. Gilman, '23, William R. Hewlett, '36, Theodore V. Houser, Emanuel R. Piore, H. B. Richmond, '14, Robert C. Sprague, '23, chairman, and Dean E. Wooldridge. Alexander C. Monteith was unable to attend the meeting.

Representing the Administration were: James R. Killian, Jr., '26, President; J. A. Stratton, '23, Chancellor; C. Richard Soderberg, '20, and H. Guyford Stever, Dean and Associate Dean, respectively, of the School of Engineering.

The Committee was joined in its discussions, except for the executive session, by senior members of the Faculty. The Committee came to the following conclusions on the several major issues presented for discussion.

(1) The Committee visited selected departmental laboratories in which graduate and Faculty research is conducted, and was much pleased with the presentation on the graduate research activities in the Department and with the breadth and depth of the work that is being undertaken.

(2) The Committee was enormously impressed with the progress which has already been made in the revision of the undergraduate curriculum and endorses the plans of the Department for the further contemplated changes.

(3) The Committee enthusiastically endorses the Department's proposal to investigate the most appropriate way of instituting a Course VI-B program aimed at a more effective integration of graduate study with undergraduate study.

(4) The Committee is sympathetic to the desire of the Institute's Administration to co-operate with local industry by providing opportunity for further professional education of young scientists and engineers on the staffs of industrial companies. The Institute must keep in mind that its basic responsibility is at the national level; hence, it is conceivable that its program would deviate from that which some local industrial interests would prefer at the present time. The Committee has the conviction that the Institute's first responsibility is to maintain the highest attainable standards in its educational program and that the decisions with regard to any co-operation with industry in this matter should rest with the Institute.

(5) The Committee reviewed enrollment statistics and found that 48 per cent of the total freshman class indicates a desire to enroll in either Physics or Electrical Engineering. Also, 42 per cent of the sophomore class is enrolled in these two Departments. In recent years, enrollment in Electrical Engineering has moved from 17½ per cent to 22 per cent of the total M.I.T. enrollment. Of more significance is the fact that the percentage increase has

*Members of this Committee for 1956-1957 are: Robert C. Sprague, '23, chairman, H. B. Richmond, '14, George W. Gilman, '23, Max I. Alimansky, '28, William R. Hewlett, '36, Theodore V. Houser, Alexander C. Monteith, Emanuel R. Piore, and Dean E. Wooldridge.

Class of 1916 Dinner

Members of the Class of 1916 held an informal dinner at the Hotel Chatham in New York City on May 1. Left to right, at far side of table are: Herbert Mendelson, Arthur Caldwell, George Petit, William Barrett, James Evans, Gilbert Gauss, Richard Berger and Class President Ralph Fletcher. At head table, left to right, are: Harold Whitney, Thomas D'A. Brophy, David Patten, Walter Binger, and Marshall Wellington. At right-hand side of table, far to near, are: Harry Smith, Francis Stern, Harold Dodge, Leonard Stone, Ping Yok Loo, Harvey Stocking, Isidore Richmond, Richard Rowlett, Joseph W. Barker, and John Woods. Although the dinner was planned primarily for members in the Greater New York Area, a few from the Boston area were present.

F. S. Lincoln, '22

been considerably higher in the second, third, and fourth years, while the number of graduate students in the Department has been held substantially constant. Concurrent with the above, the so-called service load of the Department has not decreased.

The Committee would be reluctant to see an arbitrary ceiling placed on the registration in Electrical Engineering without having some reliable prognosis of need for electrical engineers – specifically of the M.I.T. type – five or 10 years hence. It believes that there were sound grounds for the belief that the future needs for scientists and engineer-scientists should increase rather than decrease. It was unanimous in its belief that to the maximum degree the student, once admitted, should have free choice of his major department. The Committee understands that the total undergraduate enrollment at the Institute will remain approximately constant, although some increase in the size of the graduate school is expected and should even be encouraged for the Department of Electrical Engineering.

At the end of the meeting the Visiting Committee congratulated Professor Gordon S. Brown, '31, Head of the Department, and his entire staff for the great advance in educating electrical engineers which had been conceived and initiated by his Department in the last several years, and as represented by the present courses of study in the Department.

The report of the Visiting Committee was approved for publication in The Review at the meeting of the Executive Committee of the Institute on April 5, and was received by The Review Office on May 8, 1957.

Harry J. Carlson: 1869–1957

■ Harry J. Carlson, emeritus life member of the Corporation, died at Brooks Hospital, Brookline, on June 16. He was 87 years old.

A prominent Boston architect, Mr. Carlson was partner in the contracting firm of Coolidge and Carlson from 1903 until his retirement in 1950. His work included the design of many college and office buildings, churches, and residences. He was elected a life member of the M.I.T. Corporation in 1921, and in 1953 became life member emeritus.

Born in St. Paul, Minnesota, Mr. Carlson attended M.I.T. with the Class of 1892 and then studied at Atelier Duray, Paris. After working with W. S. Sampson and Company, contractors, he established an independent architectural practice before the turn of the century. He had also been a lecturer on architecture at Massachusetts Normal Art School and, when M.I.T. was still in Boston, was one of President Maclaurin's three architectural advisers on a location for the new M.I.T. buildings. Bates College awarded him an honorary master of arts degree in 1928.

Mr. Carlson was a trustee of the Newton Savings Bank, past president of M.I.T.'s Alumni Association, life trustee emeritus of Bates College and member of its board of overseers and finance committee, and fellow of the American Institute of Architects. He had also been an active leader in the Boston Society of Architects, Boston Chamber of Commerce, Boston section of the American Academy in Rome, Massachusetts Library Aid Association, and International Y.M.C.A. Formerly a member of the board of visitors of the Harvard School of Architecture and an architectural adviser to the Massachusetts State Library Commission, he was a member of the Neighbors Club, Newton Centre, and University Club.

Always active in M.I.T. Alumni activities, Mr. Carlson was president of the Association for 1922-23, and served on numerous Alumni committees throughout the years.

Mr. Carlson was in charge of design and construction of the west wing of the dormitory quadrangle directly behind Walker Memorial Building and in the same year, 1930, the firm of Coolidge and Carlson designed the new main physics building at the Institute. In 1937, Mr. Carlson was supervising architect representing Welles Bosworth, '89, for the new School of Architecture Building on Massachusetts Avenue, Cambridge.

Inertial Guidance Disclosed

■ Details of a new jam-proof form of navigation for airplanes, missiles, and ships developed at M.I.T. were disclosed at a press conference on April 18 by Charles S. Draper, '26, Head of the Department of Aeronautical Engineering.

Without magnetic compass, radio, radar, or a glimpse of the earth, the sun, or stars, the "inertial guidance" system promises to make it possible to pilot any craft to any spot on earth. It will certainly be of very great importance as a part of any system for navigation through space – to the moon or Mars – if such trips become feasible. It has been described as "astronomy in a closet," by Walter Wrigley, '34, Professor of Aeronautical Engineering, who spoke on inertial guidance navigation before the Alumni Council at its meeting on May 28, 1956.

The system cannot be jammed by enemy electronics. Natural phenomena, such as weather, sunspots, and magnetic influences in polar flights do not interfere with it.

The heart of such a system is the gyroscope, which is being applied to flight control and fire control as well as to navigation. Military application for all three uses has been developed largely by the Instrumentation Laboratory, which has been operated by M.I.T. since 1939 under contracts with the Air Force and Navy.

Professor Draper, Director of the Instrumentation Laboratory, and Professor Wrigley, Educational Director in the Instrumentation Laboratory, have been largely responsible for the development of inertial guidance.

Sir Isaac Newton's laws of motion describe physical phenomena as seen by an observer standing in space and able to see the earth rotating. It is sometimes said that any space that is unaccelerated relative to the "fixed stars" is an intertial space. The "earth space," fixed to our world, is not inertial space because of the earth's rotation. The rotation of the earth is too slow to cause earth space to be detected as different from inertial space, except for measurements made with highly precise instruments. This small but detectable difference, however, makes inertial guidance possible. Forces that depend on changes of motion with respect to this special inertial space can be measured by self-contained equipment.

A spinning gyroscope resists any movement to change the plane in which it is spinning, and can be designed and built to be so free from disturbances that it continues to point along the same direction in inertial space regardless of the direction in which it is carried by the earth, an airplane, a missile, or a ship. When the direction of the craft is changed, the direction of the spin axis of the gyroscope "stays behind" so that it can be used to give information concerning the change in direction of the craft.

Another instrument that is essential to inertial navigation is a device which will always point "down" – toward the center of the earth. An ordinary pendulum would do this on a stationary platform, but on a moving craft that is undergoing any acceleration it would appear to swing backward because of its inertia when the airplane was given a forward acceleration. Therefore, a special kind of device had to be developed which (as far as this simplified explanation is concerned) always points "down," regardless of an airplane's acceleration. The Instrumentation Laboratory developed such a device, known as a Schuler-tuned pendulum, based on a principle first proposed by M. Schuler of Germany more than 30 years ago.

Inertial navigation is thus made possible by combining two instruments – the gyroscope which holds information on the direction in inertial space of the vertical that existed at the point of departure and a pendulum-type device which shows the vertical that exists at any point at which an airplane is located during its flight. By using a clock to correct for the rotation of the earth and measuring the angle between these two verticals, the latitude and longitude of an airplane may be determined. The inertial guidance system not only determines this position continuously as the airplane proceeds but does it automatically and, in fact, directs the craft to its destination. The mechanism that accomplishes this is, of course, far more complex than a summary of its elements indicates.

The inertial guidance system resulted from research begun in 1939 by Dr. Draper. He headed a research group at M.I.T. which developed the Mark XIV Gunsight under the sponsorship of the Sperry Gyroscope Company and the U.S. Navy Bureau of Ordnance. In the first battle experience after it was installed on the *U.S.S. South Dakota* and destroyers, 32 Japanese attacking aircraft were shot down – a remarkable record. It was adapted for use with other naval and antiaircraft guns.

The Instrumentation Laboratory at M.I.T. is under the administrative control of Admiral Edward L. Cochrane, '20, Vice-president for Industrial and Governmental Relations. The Division of Sponsored Research, which F. Leroy Foster, '25, directs, administers contracts with the armed services under which these developments have been accomplished.

At the present time the laboratory has a staff of 700 working in laboratories in Cambridge and a flight facility at Hanscom Field at Bedford, Mass.

Roger B. Woodbury, '48, and Forrest E. Houston, '48, Associate Directors, have been responsible for technical direction of inertial systems engineering, which has been accomplished by groups under the leadership of Joseph E. DeLisle and John W. Hursh, Assistant Directors. Many important developments of gyroscopic components have been carried out by laboratory sections headed by William G. Denhard, '42, and Lester R. Grohe, '54.

The Instrumentation Laboratory not only has been responsible for the development of gyroscopic instruments but is an educational branch of M.I.T., conducting courses in weapons systems for graduate students under the general supervision of Professor Wrigley. There are now 60 officers and civilians enrolled in the courses, most of them working for master's degrees although some are doing doctoral work in instrumentation.

The work of the laboratory on front-line engineering problems provides a unique environment for undergraduate and graduate students in aeronautical and instrumentation engineering.

Visiting Committee Report on Libraries

■ The Visiting Committee on Libraries met on May 12, 1956, with the following members present: John A. Lunn, '17, chairman, John W. Barriger, 3d, '21, Verner W. Clapp, Herman H. Henkle, and Edwin D. Ryer, '20.* In addition, Julius A. Stratton, '23, Chancellor; Professor Philip M. Morse, Director of the Computation Center; Professor William N. Locke, Director of Libraries; and Robert M. Kimball, '33, Secretary of the Institute, met with the Committee, as representatives of the Institute's Administration.

The chairman reported briefly on the resignation of Vernon D. Tate as Director of Libraries and the appointment of Professor Locke as Director. Mr. Lunn explained that in view of the impending change in administration, the Library Committee did not meet in 1955.

Professor Locke described the present organization of the Library resulting from the implementation of the Metcalf Report of two years ago. The reduction from nine branch libraries to five divisional libraries is in full effect and appears to be working out well with considerable economies of operation. There appears to be a sentiment among some of the Faculty that the consolidation is causing them real inconvenience and that a good case can be made for the educational advantages of creating one or more new branch libraries. The Committee expressed the feeling that the library administration should continue to review the special needs of individual departments and groups but at the same time expressed the hope that the advantages of a consolidated library would be maintained, especially in the use of stacks in the Central Library for shelving of less used portions of collections related to divisional or branch libraries.

Professor Locke introduced the following librarians and heads of departments who reviewed the activities in their respective areas.

Librarians: Miss Barbara Klingenhagen, Dewey Library; Ralph R. McNay, Engineering Library; Burton A. Robie, Humanities Library; Miss Caroline Shillaber, Rotch Library; Miss Marguerite Chamberlain, Science Library.

Department Heads: Miss Eleanor Canty, Acquisitions Department; Miss Hildegarde Ziegler, Catalogue Department; Miss Louise Trainor, Circulation Department; Peter Scott, Microreproduction Service; Miss Gertrude Perry, Periodicals and Binding; Miss Natalie N. Nicholson, Reference Department; Miss Eleanor L. Bartlett, Special Collections.

The Committee reviewed the several recommendations made by the Visiting Committees in the last five years and noted with pleasure that many of the earlier recommendations had already been put into effect. For example, the following represent significant developments: the implementation of the Metcalf Report referred to above; a thorough review of the salary scale of the professional staff in the library system, with resulting increases in recent years; the several physical changes, particularly in the Engineering and Humanities Libraries. Funds have been allocated for doing the remaining work in the Engineering and Humanities Libraries in the summer of 1956 as well as for the relighting of the Rotch Library.

Many of the department heads referred to the need for additional professional staff and for larger book acquisition budgets. There was agreement among the library department heads that a definitive policy should be devised for the acquisition of new books and periodicals, whether by purchase or by gift. The Visiting Committee agreed with these recommendations but recognized that first consideration was quite properly given to the question of the salary structure. Significant steps in this direction have already been taken. The Committee also considered the question of establishing an industrial reference service, concluding that it would not be wise at the present time to try to institute such a service but that the question should be reviewed again at a later time.

The Committee specifically recommended that the Director of Libraries work toward the following objectives:

1. It appears desirable for some professional staff members to be available evenings and week ends in the libraries. Currently, the libraries are manned entirely by graduate students, after working hours.
2. Reduction of book losses is desirable. Some plans have already been formulated and approved for meeting this objective but it may be necessary to take further steps. The Committee expressed the view that the element of public relations, in making the situation known to students and Faculty, is most important, in order to get maximum voluntary cooperation.
3. Up-to-date booklets should be prepared describing the services available in each of the major libraries, plus perhaps a booklet for the system as a whole. It is suggested that such a pamphlet include information for students on how best to use the libraries' services.
4. Use available operations research techniques to determine the relative cost of microfilming some publications (such as theses) versus binding and keeping the original documents directly available in the library.
5. Continue to explore the opportunity to use cooperative indexing services and continue co-operating with other major libraries in the metropolitan area, such as Harvard.
6. Devise a system which will eliminate duplication of effort and excessive correspondence in connection with the payment of bills for new books.
7. Consider further the opportunities to mechanize the production of catalogue cards.
8. Take the lead among scientific libraries in making available Russian technical literature. This program is now under way through the National Science Foundation and other interested groups.

The report of the Visiting Committee was reviewed by the Institute's Corporation on June 8 and by the Executive Committee in August, 1956.

*Members of this Committee for 1955–1956 were: John A. Lunn, '17, chairman, Luis deFlorez, '11, Edwin D. Ryer, '20, John W. Barriger, 3d, '21, Charles A. Stokes, '40, Verner W. Clapp, William Emerson, Herman H. Henkle, and Keyes D. Metcalf.

Visiting Committee Report on Meteorology

■ The Visiting Committee on the Department of Meteorology* met on Saturday, December 1, 1956, at the Institute. The members of the Committee present at this meeting were: Horace R. Byers, '32, Laurence B. Davis, '22, Thomas S. Moorman, Jr., Harlow Shapley, David B. Smith, '33, and Theodore T. Miller, '22, chairman. Also in attendance were: George R. Harrison and Francis Bitter, Dean and Associate Dean, respectively, of the School of Science; Robert M. Kimball, '33, Secretary of the Institute; and the Faculty members of the Department.

From the discussions at the meeting it is apparent that meteorology is evolving from an observational art to a true science. Two developments have contributed in an important way to this significant trend. A reasonably adequate mass of daily observational data from the upper atmosphere over the Northern Hemisphere has provided the basis for a description of the actual operations of the atmosphere. The development of the high-speed digital computer has made it possible to solve in a straightforward manner the basic equations that describe the motions of the atmosphere. For the first time meteorological scientists have the tools to surmount the hitherto almost insuperable barriers imposed by the mathematical intractability of the problem and the sheer bulk of the data involved. To take full advantage of these challenging opportunities the Department has assembled what is undoubtedly one of the strongest theoretical teams anywhere in the world. M.I.T. now is in a position to make fundamental contributions to the scientific bases for improving the accuracy and range of weather prediction, and even to commence to speculate on the future possibility of large-scale weather modification.

In the fall of 1956, an *ad hoc* committee, appointed by J. A. Stratton, '23, Chancellor, consisting of the Department Head and two Faculty members from each of the two Departments – Meteorology and Geology and Geophysics – formulated the future goals of M.I.T. in the earth sciences. The interim report of this *ad hoc* committee was carefully studied by the Visiting Committee, which enthusiastically endorses the proposal that M.I.T. should play a leading role in the integration and development of the major earth sciences. In the Departments of Meteorology and of Geology and Geophysics, M.I.T. already has strong resources in the areas relating to the atmosphere and the solid earth. The Visiting Committee supports the proposal of the *ad hoc* committee that M.I.T. develop even closer co-operation with the Woods Hole Oceanographic Institution so that instruction and research in oceanography will become an integral part of the program.

The Visiting Committee unanimously endorsed the recommendation of the *ad hoc* committee that the Departments of Meteorology and of Geology and Geophysics should offer a series of courses, at the fourth- and fifth-year level, in classical physics against a background of the important geophysical problems in our environment.

The Committee unanimously endorsed the proposed establishment of an Interdepartmental Research Laboratory of Earth Science. The Laboratory would provide a place for experimentation in the dynamic aspects of earth science, facilitate the interplay of the several fields upon one another, and attract strong support for M.I.T. as one of the world's great research centers in the earth sciences.

The report of the Visiting Committee was approved for publication in The Review at the meeting of the Executive Committee of the Institute on April 5, and was received by The Review Office on May 8, 1957.

*Members of this Committee for 1956-1957 are: Theodore T. Miller, '22, chairman, Laurence B. Davis, '22, Horace R. Byers, '32, David B. Smith, '33, John J. Desmond, Jr., Joseph J. George, Thomas S. Moorman, Jr., Francis W. Reichelderfer, and Harlow Shapley.

Visiting Committee Report on Mechanical Engineering

■ At the meeting of the Visiting Committee on the Department of Mechanical Engineering,* held on January 10, 1957, four important conclusions were reached as follows:

(1) The Committee believes that a broadening of the fundamental course in materials required of all undergraduates in Mechanical Engineering is desirable in principle, and recommends that the Department explore whether this can be accomplished without unduly harming other subjects.

(2) With respect to a possible new undergraduate option specializing in materials engineering, the Committee recognizes the potentiality of such specialization but believes the Department should consider carefully whether this can be accomplished at the undergraduate level without unduly diminishing the basic engineering content of the curriculum. The Committee believes this proposal is important enough to warrant consideration again by next year's Visiting Committee in the light of any curricular studies.

(3) With respect to the possibility of incorporating more textile technology in the required undergraduate course on materials, the Committee feels that consideration should be given to such possibility but that the criterion for inclusion should be whether such inclusion is desirable in order to improve the student's basic understanding of the mechanical behavior of materials. The Committee feels that the subject of textile fibers is too specialized to warrant its introduction into the undergraduate curriculum as a required course.

(4) The question of introducing a new degree in textile technology at the graduate level was not considered by the Committee because of inadequate time and because of inadequate background with respect to the scope of the Department's present activities and long-term aims in the graduate field.

The report of the Visiting Committee was approved for publication in The Review at the meeting of the Executive Committee of the Institute on April 5, and was received by The Review Office on May 8, 1957.

(*Continued on page 526*)

*Members of this Committee for 1956-1957 are: Walter J. Beadle, '17, chairman, Max L. Waterman, '13, Charles A. Chayne, '19, Herbert G. Fales, '20, John F. Hennessy, '24, John Lawrence, '32, Jess H. Davis, Leonard S. Hobbs, and Gwilym A. Price.

The Stream of Life

In a world of increasing complexity, knowledge of science is an essential that helps us achieve security of spirit.

BACCALAUREATE ADDRESS

by GEORGE R. HARRISON

THE story has been told of an aspiring young Buddhist who entered a monastery for many years of study, to seek the wisdom and humility needed to embark on the seven-fold path of illumination. He was given the most menial of tasks to perform, and as the years went by, his duties became ever more degrading. The cleaning of the monastery pigpen, which he had been required to do as a freshman, eventually seemed most attractive in comparison with his later tasks. Ultimately the indignities heaped upon him so depressed him that he decided to give up, and he went to the worthy abbot and announced that he must regretfully withdraw, as he could not stand such degradation. "Stand up, my son," the abbot said, "at last, after all these years, you have learned the dignity of the human spirit and have passed the final test. Here is your diploma."

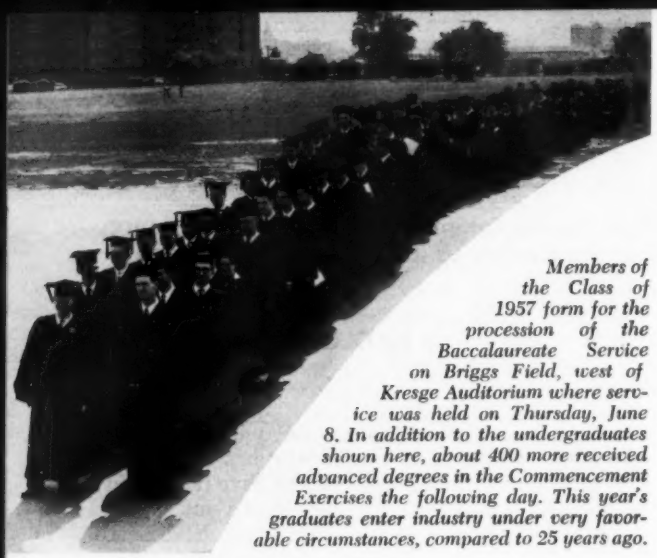
While you are not to be subjected to any such great disillusionment today, this is a good chance to discuss the reasons for some of the experiences that you have been through in the past four years. When we come back to such exercises as these twenty or forty years after our own graduations, we are likely to feel that our college experiences are somewhat different in relative importance from what we felt them to be on graduation day. Nor am I now making so prosaic a comparison as of the relative values of course work and extra-curricular activities.

The term "commencement" is losing its original meaning. Until fairly recently it connoted the time when the individual emerged from a sheltered academic environment into life, when he usually became responsible for the steering of his own ship pretty much for the first time. Today more and more of the universities, and especially those "polarized around science," are being transformed from sequestered areas of contemplation and study into communities which share active responsibility for the achievement and maintenance of freedom in thought and action by all the inhabitants of the world. Since you arrived at M.I.T. you have been immersed ever more deeply into activity that bears on this directly, and the sharpness of the chill to be expected from a sudden plunge into professional life is much less than would have been true previously. No longer can we say with Alfred North Whitehead that you are now at "the moment when the adventure of thought meets the adventure of action." If the Faculty has done right by you, and more importantly, if you have done right by yourself, you have in the past four years seen a great deal of action, and at the same time have been immersed in a reasonable amount of thought.

Not so many years ago speakers on this baccalaureate platform were counselling new-fledged graduates that, although the world would probably not have jobs for all of them for some time, they should keep stiff upper lips and eventually something useful would be found for them to do; in the meantime they could rake leaves. The chief problem then was that of nutrition. How different it is today – yet we are likely to think our problems greater now, and vastly more fundamental. Yet, problems of one sort or another must always be with us, and their absence would, indeed, be a matter for concern.

We are often said to live in a time of special crisis. Ours has been called "a war-prone generation," "a generation bent on atomic destruction," "an era of guided missiles and misguided men." One hears warnings that this may be the "final hour for choosing whether science is to be misappropriated for human folly and destruction, or embraced for salvation and a good way of life." If there ever could be such a single hour this might well be it, but life has always been, and is likely to continue to be, a perpetual succession of such hours. In our wave-train of existence, which out-Fouriers Fourier, the amplitude

Those taking speaking roles in the Baccalaureate Service of the Class of 1957 were Henry E. Salzhauer, Class President; James R. Killian, Jr., President, and George R. Harrison, Dean of Science.



Members of the Class of 1957 form for the procession of the Baccalaureate Service on Briggs Field, west of Kresge Auditorium where service was held on Thursday, June 8. In addition to the undergraduates shown here, about 400 more received advanced degrees in the Commencement Exercises the following day. This year's graduates enter industry under very favorable circumstances, compared to 25 years ago.

and the periodicity may vary greatly, but so long as there is life on earth the oscillations will continue, and in the long pull this is what makes men ever greater, more aware, and hence more alive.

In the Chinese languages new words are built up by an associative process of ideas which remains more specific in their written characters than in our own. The Chinese ideograph for "trouble" is two women under the same roof; that for "crisis" is made up of two symbols that stand respectively for "danger" and "opportunity." It is wise, of course, to stress the danger of the present crisis in world affairs, at least to the point where men are roused to doing those things which need to be done to avert danger, such as restraining governments from polluting the atmosphere unduly with radioactivity. We need, however, to give much more attention than we do to the vast new opportunities which now appear ahead, opportunities far greater and exciting than any ever seen by men before.

We are likely to be disconcerted by the present rapid shifting of social values. Young people especially are often unnecessarily disturbed by the counsels of those philosophers who, pre-occupied with the past few thousand short years of man's history, see humanity fighting a losing battle against a nature being made increasingly complex, and unnecessarily so, by man's own efforts. To get a proper perspective we need to supplement the information of human history, which still has an inordinately low signal-to-noise ratio because of the necessarily small time coverage of its measuring probes, with that supplied by the vast picture of the physical world now being made available by science, showing the splendid panorama of physical, mental, emotional, and spiritual evolution that has taken place during the past three billion years, and continues now at an ever-increasing rate.

As a physicist I have been interested in the absorption of light, not only over vast distances of space, but also through the aeons of time. When we look at our crowded highways and listen to our jangling telephones, the Golden Ages of Greece and Rome look very attractive, and it is easy to long for the simple life, and to point out that increased complexity does not necessarily mean progress. We have much to learn from classical studies, to be sure, but life in ancient Greece is gilded by the sunset on its hills; those years are golden from our vantage point to some degree because of the absorption of blue and indigo tints by several thousand intervening years. The forces of change are indeed more active today, but the view that man, with his new atomic powers, may as a result of his eternal selfishness be wiping out his own future, neglects the basic stabilizing mechanisms that Providence has developed in her creatures over the slow course of evolution, and is providing plentifully in man.

The new radioactive dating systems, where by measuring the periods of stability of exploding atoms in various strata and fossils of earth one can determine with assurance the dates of appearance of first one organism and then another, bring a new clarity to the picture of how complexity tends to increase in nature under the influence of some innate urge in living matter. Slowed-up motion pictures of the opening of a rosebud or the sprouting of a grain of barley bring home to us the eagerness of life for new expression, and illustrate the dynamic rearrangement of patterns that nature is developing in increasing tempo.

It is an impressive picture that science is beginning to present, of a universe unfolding from simplicity to complexity, from disorder to increasing order, with new entities constantly emerging, each being tried and differentially preserved according to its success or failure in adapting to its environment or, in the higher stages of evolution, in adapting its environment to itself.

Over the three billion years or more that the earth has been capable of supporting life, increasing numbers of nucleons, the protons and neutrons and associated particles that are the building blocks of our material universe, have been able to swing into new patterns of order that form atoms, many of these atoms have been grouped into molecules, many of these molecules into cells, and increasing numbers of cells into multicellular plants and animals. When some of these creatures grew complex enough to develop nervous systems, sensation and awareness came into being. We see the development – up through the jellyfish first learning to sense vaguely with eyes that barely indicate the presence of the sun, up through the termite and the wasp with their few hundreds of nerve cells arranged to control automatically dozens of stimulated actions – of electrochemically controlled servomechanisms which became ever more complex, flexible, and adaptable. Long before man is reached in the evolutionary scale emotion and integrated response have been appearing, and with the coming of that great new electrochemical switchboard in the brain called the cerebrum, reason and imagination and spiritual aspiration came into being.

We may call the directing force behind all this the breath of life, or the hand of God, or energy affecting matter, as we wish; the fact remains that the bodies of all living creatures are composed of cells, and these of molecules, and these of atoms, and these in turn of nucleons, and regardless of our belief as to what goes on behind the scenes, the scenery is most impressive.

The improved cerebrum brought a new stage in the rearrangement of patterns to form entities of increased complexity, when it enabled man to begin designing on his own. We are likely to feel that the machines made by men are in some way basically different from and inferior to those developed slowly in nature over the ages. But we must not allow our belief in directive vital forces lying behind the veil of our present understanding to obscure the fact that birds fly and squirrels crack nuts with physical devices which are machines, and machines which operate with the same electrical, mechanical, and chemical forces that man now uses to operate his electric motors and his flying machines. We can see all about us that nature is still improving her collections of servos, and that creation, instead of occurring only once at the beginning of the universe, is going on at a constantly increasing rate, and takes place by a process to which man, himself a product of the same Creation, is now privileged to make great contributions.

When nature had brought man to the point where he could really take thought, through imagination and reason he was able to make machines which often are in some specialty of operation superior to any in nature. No animal has ever lived which could outpull a diesel locomotive, outfly a DC-7, outflutter a crystal oscillator, or outspeed an electronic computer in its handling of large numbers.

All this may be considered by some to be a very materialistic view of things, but I do not intend that it be so. Art and religion, as well as science, are broad and basic paths that man has cleared in his quest for truth, and each makes its own great contributions. Each also has its own limitations, as does science at the present stage of human thought and feeling, and needs the others as supplements. It is important, then, that without in any way neglecting or decrying the importance of any particular view of the universe, we do not fail to see the true meaning of the scientific picture.

It is especially dangerous today for a statesman to be ignorant of science, for servomechanisms exist not only in the material world of machines, and in the physical and chemical parts of the world of carrots, spiders, and of men, but in the economic and social and political and spiritual aspects of life as well. Many politicians who would never dare to try to reassemble something even so simple as an alarm clock tinker today with the operations of our national economy, and do not hesitate to recommend the removal of all sorts of gears and governors from the complex mechanisms of society.

One of the great developments of our day is the rapidly improving ability of human beings to understand and to manipulate numbers. Even though we may not readily understand what a billion is, we are coming to do as well with this magnitude as our parents did with millions, and as our forebears of a century ago did with thousands. Large numbers are by no means necessarily better than small ones, but if our understanding of complexity is to increase, our ability to evaluate things quantitatively must do so also. It is less than a thousand years since the number forty was far higher than most people could conceive of. Our literature still contains vestigial remnants of this use of forty for any number too large to specify — we read of Ali Baba and the Forty Thieves, and that it rained for forty days and forty nights, or we speak of catching forty winks. I am not saying that the purpose of an education is to increase one's facility for rapid calculation; indeed, lightning calculators are usually not people of great intelligence. But the quantitative approach can contribute much to knowledge and thence to wisdom.

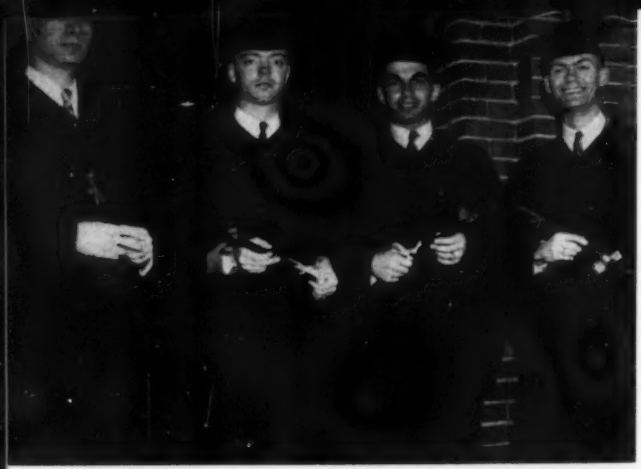
For this reason scientists and engineers are becoming increasingly preoccupied with computing machines. We recount with pride how they have replaced the pebbles and the abacus beads of antediluvian computing devices with the teeth of gear trains, then with vacuum tubes, then with the smaller and simpler transistors, and now perhaps with cryotrons and other devices. We are pleased that the giant Whirlwind computer was developed at M.I.T., and are proud that the new Compton Laboratory houses a far more complex and capable IBM 704. But what is even more important is that a good half of the 10 billion cells of the human brain consist of much smaller, more efficient, and in many ways more effective colloidal equivalents of the tubes, transistors, and other counting devices that our engineers now find so useful.

Brain Complexity and Awareness

Thousands of times more complex than the best man-made computer of today is the nervous system of any living vertebrate. In 500 million years nature has developed electrochemical calculators and signaling devices that occupy less than a gallon of space in the human body, weigh only a few pounds, and are able not only to count, but to write poems. It was partly to improve your ability to handle one of these computers, and to achieve better responsibility for its output, that you came to M.I.T.

By studying fossils and looking about us at the animal world we can see the slow improvements in complexity, sensitivity, and awareness that occurred as one breadboard model of the electrochemical nerve computer was replaced or supplemented by another. As the speed of transmission of their nerve signals increased, animals could become more complex. Signals in a clam travel along its nerves at only two feet a minute. In a crab they travel at some 600 feet a minute, in a frog at about 4,200, and in a human being at 24,000. Because a human body contains nerves which can carry impulses ten thousand times as fast as those of a clam, it has been able to develop a more active and much more complex brain. The human being that possesses it has far greater awareness than a clam or a crab or a frog, which means that we are much more alive than they. Complexity does not necessarily bring greater awareness, but it is needed before greater awareness can dawn.

All that we see or hear or feel or taste or smell, all that we are aware of, is brought to the brain by showers of sharp electric pulses, resulting from and transmitted by electrochemical changes, sent through a network of nerves from the sensory organs. In the million years that have passed since men became men, with elementary ability to reason, the human brain has suddenly doubled in size at least twice, and



Marshals at Commencement Exercises were Henry E. Salzhauer, President of Class of 1957, A. James Rowan, Vice-president, Allan M. May, Secretary-treasurer, and Fitzhugh L. Rawls, Jr., Senior Marshal.

each time has increased many thousandfold in complexity. Such rapid changes, the result of mutations, we find to be beyond the control of educational institutions.

Each of you when you came to M.I.T. brought with you the same number of brain cells that you had been provided with four months before you were born. You still have the same number, for while your brain has quadrupled in weight since you were minus one-third years old, your education has added not one cell to it. What has been changed is the size of the cells with age, and with education the ease with which groups of these cells can be connected one to another, so that new channels can be formed over which signals can flow, information can be stored and sorted and otherwise processed, and reason and emotional control and creative imagination can be developed.

Even after we have experienced a college education each of us has in the unused back rooms of our brains countless millions of circuits of the mind, which until aroused, stimulated by new associations, and correlated are likely never to be used at all in the processes of thought and feeling.

A baby ant has only a few hundred cells in its brain, and these are all hooked up in fairly permanent circuits, so that it can do almost everything it will ever do the minute it is hatched. Ants do many things which amaze us, but they need no Institutes of Technology. On the other hand, the ten billion cells of the human brain, with their flexible interconnections, make possible development of vast new areas of thought and feeling, which are as much beyond our present levels of reason and imagination as these are beyond the instinctual achievements of the spider and the ant.

New awareness often comes to us through new physical instrumentation. Astronomers have recently obtained inspiring glimpses into previously unplumbed depths of the universe by using microwaves. Perhaps nine out of every ten stars that might be visible to us are obscured by cosmic dust which absorbs the light waves on which we had previously been forced to depend to detect their presence. But microwaves, having longer wings than those of light, are able to fight their way farther through the endless reaches of cosmic dust. With the development of radar during World War II new techniques were worked out for handling microwaves. Now we can "see" stars with microwaves that light waves have never revealed, and one important kind of astronomical blindness is being removed. Your years at the Institute have, we hope, helped to unlimber new reaches of the mind, new instrumentalities of awareness, new sensitivities, which can similarly bring into your ken new stars and abilities and dreams.

We are so fortunate as to have been born into a time when man is being given a chance to understand and control his environment much more basically than was ever possible before. Qualitatively, there were as great men in the world before the Industrial Revolution as there ever have been since. But quantitatively, in terms of numbers of people having greatness in imaginative achievement, as well as being possessed of the nobler virtues, man's ability to tap the energy of molecules has been fundamental. One twentieth of all the men who have ever lived still walk the earth today, and to them has now come the opportunity to control, not merely the molecular residues of atomic forces, but these greater forces themselves, with their million-fold larger energy content.

How ridiculous to believe that energy from the atom is man's master, while that from the sun is his servant! Atoms have been exploding since the beginning of time, and all the energy that has given the stimulus for life has come from the thermo-nuclear reactor that warms our solar system.

As a matter of fact, the genie of the atom is a benevolent, constructive, and very obedient genie, whose faults are merely those of his liberators. He is inherently no more evil than his brothers who control fire or electricity or the comforting radiance of the sun.

So you are wise not to shrink back in any way from the stream of life, but to plunge into it eagerly. Instead of yearning for perpetual bucolic simplicity which (as most men slightly past the age of retirement will tell you) is not really what we want after all, we must make ourselves increasing masters of complexity, and learn to take in our stride things that previously seemed difficult or impossible.

We need to learn to adapt to change. Instead of being children playing on a raft anchored in a smooth pond, in static equilibrium with their surroundings, men must learn to behave like the surfboard rider, or the water-skier, poised in dynamic equilibrium as he shifts his weight to meet the impacts of all buffeting waves that come. Meeting these impacts successfully is what brings greater awareness, aliveness, and the creative mastery that is at the back of human happiness.

Man has always lived among forces that could easily overwhelm him. The ability to see involves the courage to look. The cave man was frightened as thoroughly, and much more often, than we. Every living creature has always lived in a balance so delicate that a slight shift could terminate its existence in seconds. Yet the whole of human development has taken place under these circumstances.

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Equality and Excellence

As a means of achieving maximum development of human potentialities at every level of individual ability, a diversity of educational institutions is essential

EXCERPTS FROM COMMENCEMENT ADDRESS

by JOHN W. GARDNER

In the years ahead those of you receiving degrees today are going to hear increasingly lively public discussion of higher education. As products of one of our greatest universities you will be presumed to have some views on the aims and consequences of higher education in America.

One of the most persistent questions you will encounter will be variously phrased: "Who should go to college?" "How shall we resolve the conflict between quality and quantity?" "How shall we serve the ideals of both equality and excellence?" As with so many other things, it will be far less important that you have pat answers than that you know how to think about the questions.

Even those who are deeply impressed — as I am — by the great positive achievements of American schools and colleges, over the past century, must agree that we have worried all too little about the individual of unusual talent or potentialities.

To make such an assertion, however, is not to deplore the unprecedented time and money we have devoted to the average youngster. Our kind of society demands the maximum development of individual potentialities at every level of ability; and it will serve no purpose to replace our neglect of the gifted by a neglect of the generality. We are all too prone to such wild swings of the pendulum in our national life. Martin Luther said that humanity was like a drunken peasant who is always ready to fall from his horse on one side or the other; and in that respect we Americans are all too human. We must learn to see the achievements and shortcomings of our educational system in some sort of embracing perspective which will permit us to repair one omission without creating others.

How can we foster excellence at the highest levels of ability and at the same time provide at all other levels constructive opportunities and rewards so that every level realizes its full potentialities, performs at its best, and harbors no resentment toward any other level? There is no single answer.

A part of any final answer would certainly be some revision of the altogether false emphasis which the American people are coming to place on college education. This false emphasis is the source of great difficulties for us and can only be regarded as regrettable. Properly understood, the college or university is the instrument for one kind of further education of those whose capacities fit them for that kind of further education. It should not be regarded as the only passport to a meaningful life or the sole means of establishing one's human worth. And we have come perilously close to that. No wonder our colleges are crowded.

The crowding in our colleges is less regrettable than the confusion in our values. Human dignity and worth should only be assessed in terms of those qualities of mind and spirit which are within the reach of every human being. This is not to say that we should not value achievement. We should value it exceedingly. It is simply to say that achievement should not be confused with human worth.

The more we allow the impression to get abroad that only the college man or woman is worthy of respect in our society, the more we contribute to a fatal confusion which works to the injury of all concerned. If we permit the confusing assumption that college is the sole cradle of human dignity, need we be surprised that every citizen demands to be rocked in that cradle?

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Participants in the Commencement exercises on June 7 were Vannevar Bush, '16, Corporation Chairman, John W. Gardner, Commencement Speaker, President James R. Killian, Jr., '26, and Chancellor J. A. Stratton, '23, in reading order.

In Knowledge Lies Security

Education entails obligation for the professional man to use his intellect and experience to advance the common account

FAREWELL ADDRESS

by J. A. STRATTON

With the presentation of the academic degrees, the high purpose of this Commencement has been fulfilled. It is my privilege to bring to you who have graduated here this morning all the good wishes of the Faculty, the Officers, and the Corporation of M.I.T. – briefly and informally, but with a full measure of pride in your accomplishment. No one, it seems to me, can participate in Commencement without being deeply moved. It makes no difference whether you are seniors, or have attained the degree of master or doctor. It is our leave-taking and a very great moment – one which you will remember all your lives. What has taken place here this morning is the culmination of so much work, of steadfast persistence despite frequent disappointment and frustration, and the final realization of many hopes and ambitions – the reward often of real sacrifice on the part of you and your families. The diplomas that you hold in your hands are the symbolic evidence of great achievement and bright expectation.

You came first to this campus only a short time ago. You flowed in, as it were, from all over the world; you came from every state in the Union, from Alaska, Hawaii, Puerto Rico. You represented 23 countries and all the continents. You brought to us the variety of experiences, the profusion of cultures and traditions and faiths that is the heart of America. Yet with all this diversity you had also many things in common. You demonstrated unusual qualities of mind, with a disposition for mathematics and a great motivating interest in science and its applications. Each of you gave promise of energy and ambition and a sense of purpose. To these qualities it seemed to us that you added integrity and firmness of character. Your admission to M.I.T. was a privilege which you had earned with merit.

You have been with us really a very short time indeed, and today, so soon, you disperse again – some to graduate study, others to the wide range of occupations and professions that now lie open before you.

Acquiring a Professional Foundation

Out of this brief experience will have grown lifelong friendships, and I do believe that you carry away the imprint of a great institution of learning and the proud heritage of an M.I.T. education.

You brought to us your talents and we have tried to bring them to fulfillment. It has been our aim to develop habits of thought and methods of attack to see you through the difficult and challenging years ahead. We have done our best to give you a firm grounding in mathematics and physics and chemistry. Even with the undergraduate years you began to acquire the foundations of a profession. Through the humanities you have come to sense the vast sweep of great ideas and human problems so that you might awake to the wider responsibilities of scientists and engineers in modern society. By design we have avoided the mere accumulation of factual data and preoccupation with those special techniques useful today and obsolescent tomorrow. For all our efforts we shall be content if only we have succeeded in imparting to you the confidence that, even though you don't know the answer to a problem, you have within yourselves the resources to attack and to resolve it.

Crucial Test of Educational Plan

The crucial test of every great plan of education lies in its relevance to the conditions of the age. In this sense you may be confident that wherever your career may lead, the methods and the principles you have absorbed in these years at M.I.T. will serve you well. Within the lifetime of you who are graduating today there has been an almost explosive growth in the technology at our command. So swift has been the rise of science and engineering as shapers of our society, and of all civilization, that many still fail to grasp the breadth and strength of their influence. But I believe that we can say to you with all honesty that your education is well adapted to this world in which you will live.

One of the sharpest criticisms commonly made of your generation is your preoccupation with economic security. The only lasting security lies in the power that comes from knowledge. Remember, therefore, that there is no static frontier of science. You must keep pace with its advances. As Dean Harrison told you yesterday in his Baccalaureate address, Commencement no longer marks a sudden emergence into full professional status. Education is more than ever in this age of ours a continuing process. You will never be able to rest solely on the knowledge you have acquired, but with this strength you have gained you need never fear the progress of science nor the innovations of technology. You have invested your future in these years at M.I.T. You carry away with you today the only wealth that is proof against

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Physical Science and

Today's Science — Tomorrow's Promise

SYMPOSIUM ADDRESS

by JAMES B. FISK

THIS prophecy, made at any time in the past two centuries, would have been borne out ultimately by what followed. The promise of earlier times was that certain parts of nature would be understood. Much less was it then a promise of depth and breadth and unity of understanding, or of the control of nature that knowledge gives, or of the humane ends which science could serve. Science is the rational foundation for the practical arts and industries and for the physical means for our national defense, but they are not all equally well rooted in science nor, in the past, has science always been the strong partner it might have been in our society.

There have been giant steps in the history of science: Newton's laws of motion which are the basis for the science of mechanics; Maxwell's equations and Faraday's laws which are fundamental to all of electrical science and much of physics; and the heroic work of Max Planck which underlies modern quantum physics. Such peaks of achievement have justly commanded the respect of following generations. But let us not lose sight of the fact that in our industrial history the practical arts have produced profound changes, often without much help from science.

Tomorrow's promise is that today's science will more rapidly broaden our understanding of nature; that it will provide deeper roots for broader segments of tomorrow's life and work; that it will provide greater choice and greater opportunity; and that it will give sounder means for making the choices which will have to be made.

We who are part of the world of science and technology accept as an axiom — based on observations from experience — that today's science is tomorrow's promise. The newcomer, however, and those who are not themselves a part of science and technology, although surrounded by it, deserve some understanding of the methods and results and implications of science. And the skeptic must be assured that science and technology have not run their course — rather that there is no end to new knowledge and no end to its fruitful employment.

It has been fashionable to speak of the industrial revolution and the decades that followed as the times when men's muscles were supplemented or replaced or extended by machines. Today it is fashionable to speak of electronic brains. Both analogies are attractive and both are useful if not pursued too far. We will come to an electronics analogy, but let us spend a moment first on muscles and machines. The old and familiar example of the increase in man's capacity for doing work is worth recounting for we can see, quantitatively, how far we have come. Also, we can see, qualitatively, that there is still something left to do. The example gives evidence that yesterday's science has shared importantly with technology in building today's reality.

A strong man, for a few minutes, can do work at the rate of about one horsepower — which means, for example, that he can climb a hill 200 feet high in about one minute. In sustained effort he could hardly do work at one-tenth that horsepower. To overcome this limitation, the sciences of mechanics and thermodynamics, of metallurgy and chemistry and electricity have joined over the years in fruitful combinations. Ingenious engineers have taken from science what they needed and could use and have produced a great array of machines. The capacities of the lone individual for doing work have truly been extended. With a small tractor man may control 10 or 100 times his former mechanical power. A bulldozer or a large earth-moving machine gives him another factor of 10 or 100. The driver of a large Diesel locomotive controls 10,000 horsepower. The master of a large ship controls 100,000 horsepower. Thus, in a sense, there has been an increase of a *millionfold* in man's capacity for doing mechanical work.

In this example, which is not unique, I might first have observed that with the conversion of energy into useful forms we can now do many things which earlier could not have been done at all — or only at great cost or inconvenience. But I would rather emphasize the factor of 1,000,000 which is a measure of achievement, and note the word "control" which I have used several times. Control — in the mechanical analogy with muscles — is important, and in the fields of electronics and communications which we are coming to, it is essential.

The science of the past gives the rational basis for the utilities and necessities, the economic adjuncts of our society. In part, it is in the basis for the present character of our society itself. Our position is being advanced — not so much by invention, as in the past; invention itself is no longer the criterion of progress — our position is advanced primarily by the novelty of original and unexpected discoveries in nature coming from basic research. The science of today is more vigorous than it has ever been. If science and the most basic research are maintained in a healthy state there can only follow a future richer and more abundant than the past.

Symposium speakers Jerrold R. Zacharias (left) and James B. Fisk, '31 (right), confer with Chancellor J. A. Stratton, '23, who presided at Alumni Day Conference.

I expect you are now impatient. You have heard such assertions and expressions of faith before. Where, you will ask, can we look for significant happenings? And what are they likely to be? The answer, of course, is that no one really knows. The only thing we can be absolutely sure of from science is that there will be greater understanding of the world we live in. There will be change and there will be improvement.

Each of us can make his own catalog of changes that have taken place over the past years. Some of these are so great and so dramatic that we may tend to overlook the more gradual, cumulative importance of hundreds of others. I suspect that if some catastrophe were suddenly to undo the cumulative changes of the past 50 years – in transportation, communication, power, accessories, food, medicine, and the rest – we could not function as a civilized society. The skills and crafts which nurtured the self-sufficiency of our forefathers are largely forgotten. But this is the path we are following, and I suspect, further, that the cumulative changes in some much shorter period in the future will be equally great.

Now, taking refuge in probabilities, we can make some cautious observations and predictions.

The life sciences, biology and medicine, certainly give strong promise of advance and change. The sciences of chemistry and physics and mathematics are now joined with the life sciences in powerful assault on the understanding and control of disease.

The agricultural sciences are by no means dormant. Agriculture has drawn from many sources; from biology and from chemistry, and from all the sciences which have given us machines. Food is not a problem to us today. Some day it may be and science will surely meet this challenge.

The sciences of materials – particularly the physics, chemistry, and metallurgy of solid materials – have gone forward with extraordinary vigor since World War II. Materials in common use whose properties are *understood* range from plastics and fabrics unknown a few years ago to ceramics and metal compositions with properties previously unattainable.

Almost everything we use or work with, and all of our structures, are made of solid materials. Throughout history separate technologies grew up in the materials industries without much science to support them or to tie them together. But this is no longer the case; we are in a renaissance. We are no less interested than before in such questions as the strength of structural steel or the ability of some materials to conduct electricity, or the magnetic properties of others. The changes lie in the point of view, in the cohesion of knowledge and in our greatly increased understanding.

Science now asks and finds answers to such questions as these: What are the *atoms* – all of them – which make up the solid? How are they arranged – or disarranged? How did the arrangement come about? And what properties result from the atomic arrangement?

Who would have suspected that one "foreign" atom among 10,000,000 "native" atoms – for example, one atom of phosphorous in 10,000,000 atoms of silicon – would have a measurable effect on the important electrical properties of silicon? Or who would have suspected that occasional atomic vacancies (missing atoms) or dislocations in an otherwise perfectly ordered array of atoms in a crystal would alter the strength of the crystal by a factor of 10 or 100?

Understanding the atomic, the microscopic structure and composition of a very few substances in nature, is the basis for a whole new industry; solid electronics. The family of transistors, and their close relatives, have led to improvements; to better ways of doing things we already knew how to do. More importantly the new devices are leading to change; to doing things that were not possible or not feasible to do before.

The new solid-electronic devices and the new services they will perform are much to be commended. And they have been. There is, however, a broader philosophical point to make. Increasingly, the deep understanding that comes from scientific inquiry is preceding technology and leading the way. The transistor is a fine example. It came directly from enlightened, basic research. Hundreds of useful inventions have followed. The same approach – and it is being made in many fields today – is part of tomorrow's promise.

Now, for a moment, let us turn to nuclear science and atomic energy which are much in the public eye. Two obvious and outstanding facts are these: The destructive energy available in a single bomb, transportable by air, has increased a millionfold in 12 short years; and the energy available from the fission of uranium atoms for the production of power is likewise concentrated.

What this energy concentration may mean in peace and war is not solely a technical question. I don't propose to discuss it. Let us observe simply that nuclear science in the broadest sense is perhaps the most active and vigorous field of scientific inquiry today. And let us observe in passing that nuclear science also involves intimately one of the major new aspects of modern science and technology – quick and precise sensing and measuring for the control of nuclear energy and for insight into all

Exterior view of the Karl Taylor Compton Laboratories which were dedicated at ceremonies in the afternoon of Alumni Day, June 10. The Computation Laboratory is housed in the one-story annex at the extreme left. At right the new Compton Laboratories connect with the Dorrance Laboratories of Biology and Food Technology. The five-story Karl Taylor Compton Laboratory will be used for teaching physics, as well as for research in electronics and nuclear science.

nuclear phenomena. The means of measurement and control are largely electronic.

Closer to home are the interrelated fields of electronics and communications and the physical sciences on which they depend. For this part of my discussion it will be useful to turn to analogy again for a scaffold to construct the argument.

A general analogy and perhaps a suitable one for the moment is the central nervous system in comparison with the functions which electronics and communications now perform and which we may expect them to perform. In brief, the central nervous system performs these functions: Through a variety of sensing elements it receives information. Information is transmitted through the system. The information may be stored more or less permanently for later reference, stored temporarily, or used immediately. Logical operations are performed which we call thinking (sometimes non-logical operations are performed). Signals or commands are then transmitted which result in some action. Additionally, there is what engineers call "feedback" – some means by which the response to a signal or command is monitored and controlled.

Thus the human central nervous system provides the means by which the activities of all of the parts of a man are made to work effectively with each other and with his environment. In just the same way the various parts of our modern society can work effectively together only because information can be collected, transmitted, remembered, and used. A major achievement and promise of modern electronic and communication science is that it provides and will continue to provide increasingly effective means for these vital information handling functions of our society.

A quantity as important to mankind as information deserves to be measured. Science has given us a new concept, a new tool, called information theory which permits us to measure information and in many situations to estimate the size and complexity of the electronics and communications job and to tell us how efficiently we are doing it.

But first, some definitions and a few numbers. Information can be conveyed in a variety of forms. For example, a knock on your door (a pulse of sound energy) tells you someone is there. A particular sequence of knocks (or pulses) may tell you who it is. Thus, an elementary form of information is a pulse of energy, and the smallest quantity of information is a "bit," such as a single pulse. The term "bit" is a contraction of the two words "binary" and "digit." For our purposes it is enough to say that a "bit" of information is essentially a "yes" or "no"; either a pulse of energy is present at a particular instant or it is absent. This is not as strange a concept as it may at first seem. We have all received telegrams and we know that the actual letters and words we read did not come over the wire. What came were electrical pulses – bits of information – arranged in such a sequence that they could easily be converted into characters and words.

Now there is good evidence that the nervous systems work with small pulses of energy and bits of information. The language of modern electronic computing machines is also the "bit." And when you use the dial on your telephone, the dial pulses which precede your telephone connection carry the bits of information which tell the telephone central office what number you want and how to set up the connection automatically.

The human mind is said to have ten thousand billion neurons and can, presumably, store a comparable number of bits of information. A modern telephone exchange or switching center has a memory capacity of about 100,000 bits and a large electronic computer or business machine has capacity comparable to that of a telephone exchange. On the other hand, measurements show that a human being can absorb only about 40 bits of information each second in ordinary reading, whereas electronic machines can today operate at a rate of 1,000,000 bits per second.

Thus, we see some qualitative similarities in our analogy as well as quantitative differences. The analogy also includes some clues for the evolution of electronics and communications, and a role for the physical sciences beyond their more familiar role in materials and in the conversion and uses of energy.

Electronics and communications deal with "information." Any information which can be converted into electrical form is fair game, and science has taught us how to convert almost all kinds of information into electrical form. The native habits of

electrons in materials, and the physical effects nowadays recognized as resulting from them, are turning out to perform just the functions laboriously sought from "electricity" in the earlier communications and power technologies. Microphones, transmitters, and receivers convert sound into an electrical equivalent, or vice versa; photocells and television cameras convert light into electricity; electronic gauges detect and measure otherwise imperceptible mechanical motions; temperature, molecular motions, the flow of gases and liquids, the thickness of sheets of metal or plastic, the disintegrations of individual atoms, and the passage of cosmic rays through the atmosphere — all can be detected and measured electronically. Sensing and measuring is done not only in close contact but also at a distance, as in the example of radar, where electrical waves, or pulses, together with complex electronic gear measure the position and velocity of objects many miles away.

In the handling of information we must discuss storage or memory, which I mentioned a moment ago. Information, if it is not to be used immediately, must be stored or memorized. Sometimes it need be stored but a few millionths of a second, sometimes very much longer. A tiny magnet, the size of a pinhead, can store one "bit" of information; so can a whole class of substances called "ferroelectrics" which in useful forms are newcomers in the field. So, too, can a photographic plate store information — and a great deal of it; and so can a speck of "phosphor" such as each of the many specks of phosphor which cover the face of your TV tube.

Information, to be useful, must be available when it is needed and be available quickly. If it is not already obvious, electronics has one outstanding virtue. It is fast. Information cannot only be transmitted fast, it can be memorized fast and retrieved fast: 1,000,000 times per second is common practice today.

In providing the varied means to do these things, science has also provided us with the means to manipulate the information we have at hand. All of the essential and basic logical operations (for example, the arithmetic operations) can be performed at these same speeds by combinations of electronic devices. The new devices from solid-electronics are small, reliable, and efficient, well adapted to their new chores in contrast to the devices of a decade ago.

Next, let us look briefly at the transmission of information, a vital part of the job. Communications is a highly technical industry, and it is very firmly rooted in the physical sciences. Perhaps more than in any other industry its science has been cultivated, and cultivated in close partnership with its technology. The larger promise of science has been met and is being met.

For example, we have all become accustomed to telephone calls across the country or, more recently, under the ocean with fidelity of transmission equal to that of calling one's neighbor. And although we have all seen television pictures which have been sent over great distances, few realize the hidden complexities of such transmission and interconnection. Few realize that the voice now carried by cable under the ocean is "repeated" or amplified by a factor of 10,000 at each of 50 different points along the ocean floor. The total amplification is a very large number. It is 1,000,000 multiplied by 1,000,000 more than 33 times or in simple terms 10^{200} (a number far greater than the number of particles in the universe). But even in this technically sophisticated industry the change we see directly ahead is greater than at any time in the past. It is predicated on what we have learned in the past few years from science, from basic research, from new understanding, new materials, new devices, new methods.

As you can see from what I've been saying, we have in hand means to perform each of the simpler functions of the central nervous system. In some respects electronics and communications have the edge: they can transmit and handle information *much* faster than a human and they can provide for action at a distance. In other respects they are more limited: the memory capacity of electronic machines is far less than human memory and, although "feedback," which I mentioned earlier, is used extensively in electronic systems, we are just beginning to teach machines a more subtle human form of feedback — namely, learning by trying.

The fact that electronic machines are "simple-minded" is of course a handicap, but they can afford to be simple-minded. They make up in speed much of what they may lack in sophistication or flexibility. Again there is a factor like 1,000,000 before us; a measure of electronic capability, a measure of achievement.

Science and technology have served us well. We are now on a high plateau where our material needs and our material wants are abundantly cared for. We have abundant power to do our heavy work. There is no doubt that science can maintain and improve our present position and, increasingly, the living standards of the rest of the world.

The challenge, and the promise, is not solely that we do these things: rather that we do them well and efficiently and do them for the best ends of human welfare. The increasing complexities of modern life place unusually high premiums on information and on its efficient use and, therefore, high premiums on electronics and communications. The effective conduct of our national life, of business, of industry, and of our national security depends largely on intelligent information, intelligently used.

Parallel Challenge — Parallel Promise

Today's science promises the understanding, the materials, the devices, and the methods to meet the technical challenge. But science has had little to say on the less technical questions of what information is of value and on how the information is to be used. So there is a parallel challenge and a parallel promise; that today's *scientists*, with increased social responsibilities in a highly technical world, will provide sounder bases for decisions. Science permeates and will continue to permeate our society. It is important that science extend a firmer hand to society, and important, in turn, that society recognize the understanding and the strength that science offers.

Educational Methods and

Today's Science — Tomorrow's Promise

SYMPOSIUM ADDRESS

by JERROLD R. ZACHARIAS

In November of 1956 the National Science Foundation made a grant to M.I.T. in support of an effort to improve the teaching of physics in the secondary schools. A group was established under this grant, called the Physical Science Study Committee. It now consists of physicists from many universities and from industrial laboratories, of high school teachers and of educators. It is doubtless for this reason that I have been asked to speak on this symposium — "Today's Science — Tomorrow's Promise." How can we help fulfill it? It is my intention to report to you on our progress to date and on our plans. But before I do I must make a point which is stimulated by the title of the symposium.

To many people, science is regarded as a kind of seed corn to be grown and hoarded, in case at some future time, we need to grow a new crop of technology — to give us *more* — more *things*, more *leisure*, more *control over the forces of nature*, more mechanisms for the besting of our rivals and more devices for the confusion of our enemies. But to many of us who work in science, in laboratories, who work at theory, or teach science to younger men, we think of science as a part of our culture. Man is different from the lower animals, not so much because he uses tools for his betterment; a chimpanzee can pile a box on a stool to reach a banana, the beaver, the symbol of M.I.T., builds his dam of things for his own betterment, and the spider uses automation. We are different from other animals, we hope, in that we are trying to understand our world, our universe. We strive to know the *meaning* of the things we see in nature. In many ways, the more we try to discern the orderliness of nature, the less conspicuous does man become. The great telescopes — even now the radio ones — seem to make us feel less conspicuous in the scheme of things, and worse, leave us with those peculiar feelings of wanting to know what's out there beyond what we see. And in the other direction, toward the small, the more we seek to see the tiny things — the atoms, their nuclei, the constituents of the nuclei — the more we see how difficult it is to think clearly without having nature herself show us the way. A prodigiously elusive sub sub particle of matter, the neutrino, is just beginning to become clear. But I would rather understand the role of the neutrino in nature than to harness it to make longer tails on our cars.

To return to our subject, the Physical Science Study Committee considers itself to be engaged in an experiment of five or more years' duration. Its point of view is expressed in three interrelated aims: (1) to present physics as an intellectual and a cultural pursuit which is part of present-day human activity and achievement; (2) to plan a course of study in which the major developments of physics, up to the present time, are presented as a logical and an integrated whole; and (3) to assist existing physics teachers, by means of various teaching aids, to carry out the proposed program.

The realization of these aims will require considerable effort over a considerable period. The Committee has studied various approaches in order to learn how best to prepare a realistic, effective program. The subject matter will be presented to teachers and to students through several media concurrently: *textbooks, manuals, films* and *film strips, classroom demonstrations, laboratory work*, and *work that a student can do on his own* — using what I call kits for kids.

The situation of science in high schools has been recently the subject of many discussions both among the public and among educators, and is widely known. For a brief review of it, attention may be focused on three main factors: the student population; the teachers; the curriculum.

The basic pattern of our high schools was *set at least* 80 years ago. At that time only a few children

Fig. 1. (left) Blackboard diagram of simple apparatus by which pressure of light may be demonstrated. Fig. 2 (right) Common form of radiometer at left with evacuated tube containing aluminum foil vane supported by quartz fiber to form torsion pendulum for demonstrating light pressure.

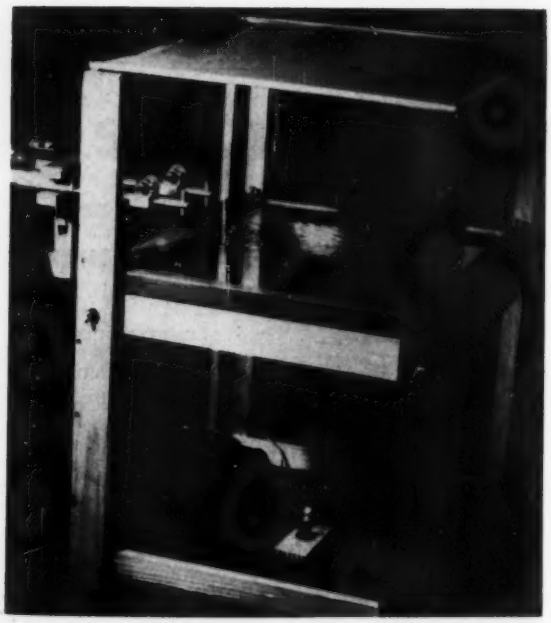


Fig. 3. Simple apparatus for demonstrating waves may be made by combining into wooden frame automobile taillight (bottom), horizontal window frame with layer of water (center) and oiled paper projection screen (top). Battery-driven toy motors agitate celluloid balls immersed in liquid to produce waves.

went past the elementary school. A much larger proportion of children is now attending high school, and the total population of children is rapidly increasing. Forecasts for the sixties, when those born during the "baby boom" of the late forties will reach high school age, indicate that we shall have some 9,000,000 students at the beginning of that decade and some 12,000,000 by the middle of it, as against about 7,000,000 in 1954-1955. We must learn how to educate these children.

The number of qualified high school teachers has not been increasing in the same proportion. The demand for teachers is already greater than the supply and is growing fast. This shortage is particularly acute in the case of science teachers: industries and government projects recruit more and more scientists so that fewer are left for the less remunerative jobs of teaching. A paradoxical situation has ensued: as the impact of science on society is being felt more and more, and the demand for scientists is growing, the supply of teachers is diminishing.

The third factor of the science situation in high schools is the curriculum. A special survey of physics textbooks was carried out by the American Institute of Physics, the American Association of Physics Teachers, and the National Science Teachers' Association. Many of the texts were also examined by the Physical Science Study Committee. All surveys reached the conclusion that high school physics courses present too much material, and choose that material unwisely.

Our committee has given careful consideration to the possible ways of striking a balance between two needs: the need of restricting the material taught in the course to allow time for illustrating the scientific method and the role of science in our culture, and the need of giving to a student a sufficiently unified, comprehensive, and wide view of the whole field of physics, to satisfy his broader interest. To help obtain this balance, the committee is preparing a course and supplementing it with a series of "monographs."

The course will present a reduced amount of material, and will not treat it all in the same way. Some scientific developments lend themselves to illustrate the evolution of ideas, the interrelation of various fields of human activities, the scope of physical science. These will be explored deeply, slowly, and thoroughly. The field of optics and waves and that of mechanics have been chosen for this kind of treatment. Other parts will require broader coverage: thus the role of atoms in the physical world will be illustrated in many examples throughout the course. Other parts will be only surveyed. In order to stress the unity of physics and the coherence of physical ideas, the course will be focused toward a unified picture of nature, the atomic picture. Thus the student will learn not only the physics of the past, but also the physics which is being made by men of our generation; which is affecting his present and his future; which is still an open field one of whose many paths leading to the unknown he may elect to follow.

In the preparation of the tools to implement the course the Committee is guided by two sets of considerations:

1. The most effective way of teaching, we believe, is to use several methods and media concurrently. Some parts of physics, like evolution of ideas, mathematical deductions, and so on, can best be learned if *read* over and over repeatedly and from several points of view. The significance of physical phenomena, on the other hand, will best be understood if the phenomena are *seen* over and over again repeatedly and from several points of view. And the experimental method can be mastered both by seeing how demonstrations are prepared and carried out, on film and in the classroom, and by actual experimentation in the laboratory.

2. Students learn physics not only through the formal teaching, but also by *doing* physics. Teachers must encourage and lead students to work independently, to make their own observations, and to push forward the frontiers of their knowledge. In the classroom the attention of the students must be engaged so that they listen and see and question and discuss. In the laboratory and at home they can do and question and discuss, and thus they will learn.

Among the materials which the committee is preparing for both teachers and students are a detailed syllabus and a textbook, films and film strips, manuals for teachers and for students; suggestions and equipment for classroom demonstrations and laboratory work; kits for students; monographs and selected bibliography; questions for tests and exams, for use both in the course and for college entrance examinations; placards, and so on.

Let me duscuss the educational films by showing a small piece of one, our first effort in trying to learn

how to make them. It will come at a time when the students will have learned something about light and are being shown how experiment and theory work together. We do experiments from which we make a theory. The theory suggests new experiments. We perform the experiments. We modify the theory usually as a result of the experiments, and so on. I call it right foot, left foot, right foot, left foot – experiment, theory, experiment, theory, and so on. A theory of light predicts that light should exert a pressure; that if you put your hand out in the sunlight there should be a small force on your hand pushing it away from the sun. We will break into this film at the point where our lecturer, Professor Thomas F. Jones, Jr., '40, of the Department of Electrical Engineering, is about to demonstrate this incredibly small effect.

Film

Now what is good and what is bad?

First, our man with the incredible name of Professor Tom Jones, a wizard electrical engineer, is a warm human. He is not a gnome, a "quiz kid," or a "drip." His accent helps to set the pace and his enthusiasm is real. For this particular apparatus his enthusiasm is not as great as mine, because I built it. But his is greater in the next version, which we have already made. In fact, at the time of making this film there were only a few score of people in the world who had witnessed – as you just have – the direct effect of a force exerted by a beam of light. But that statement is not quite correct. Every one of you has at some time looked up into the heavens at the stars. The big stars are held in balance by the pressure of light. Let me explain this. The heavenly bodies hold themselves together by a force called gravitation, which is small for small planets like earth and large for stars like the sun. There must be an opposing force or it would collapse to a point. For stars like our sun, this outward opposing force is due to a gaseous pressure just like air pressure only greater. Now in the large stars, say five times our sun's mass, the gravity is so great that the gas pressure is not enough to hold it out. The stars contract, therefore, getting hotter and hotter up to a point when the light pressure builds up enough to keep them puffed out. Thus this seemingly trivial effect, that we were stimulated to learn because of the theory, turns out to be one of the major structural elements of the universe. As a girder is to a bridge, so is light pressure to a star.

There are obvious defects. The film is not in good enough focus to see a diagrammatic view of the apparatus by looking at the apparatus. A blackboard diagram might look like Fig. 1 (page 501). A medium close-up view of the apparatus might look like Fig. 2. There are other obvious faults but never mind.

Let's look at what we are doing with apparatus. First, I would like to remind you that all motions are guided by the laws of waves, not just light and sound. Everything that we know about moves as if it were a wave – you, me, the atoms, the electrons, everything. The wave nature of everything was first formulated in 1926 by Schrödinger, Heisenberg, and Born, and we are just getting around to admitting it.

Fig. 4. Ripple tank picture showing circular waves produced by single source disturbance.

Fig. 5. Two sources of disturbance operating in phase produce two separate circular waves whose resultant is as shown here.

Fig. 6. Ripple tank apparatus used to demonstrate phase changes at the null positions of two wave sources. The phase changes can be seen along straight lines radiating from the common center.

So we want to enable people – not just engineers and scientists – but lawyers and doctors and politicians, too, to know what a wave is like, without any mathematics. So we don't just say, "Drop a stone in a pond." We want to explain the whole host of wave phenomena that are around us all of the time. We have to do this with apparatus that costs practically nothing – that the kids can build and the schools can use. Such a device is known as a ripple tank. A well-known apparatus company makes one to

(Concluded on page 550)

Toward the Second Hundred Years

NINTH ANNUAL REPORT

by JAMES R. KILLIAN, JR.

I HAVE come to cherish this annual opportunity which you give to me to talk about the Institute, to discuss with the candor possible only in the intimacy of the family circle our plans and aspirations, our failures and successes. Such a discussion is all the more appropriate and productive because of the exceptionally constructive and mature relationship which exists between the Institute and its Alumni.

At M.I.T. we do not have, nor do we need, the academic side-shows, the big-time athletics, the alumni whooperamas which are sometimes employed to entertain college alumni. Instead, we have a great tradition of putting education first, an austere tradition, perhaps, but one that has given this institution a style and personality and special excellence, and which wins for it a brusque loyalty that has the depth of a professional allegiance rather than the shallow emotion of a sentimental attachment. This is the M.I.T. style that prompts a reticent but uniquely authentic loyalty, and that gives our corporate life an exceptional integrity, coherence, and fellowship.

In making my annual report to Alumni, it is only fitting for me to acknowledge the splendid manner in which the Association and its officers support the Institute, and to pay tribute to all who have worked so ceaselessly and energetically to help achieve Technology's objectives. This year your President, Theodore T. Miller, '22, has travelled far and wide in advancing the Institute's aims. He has visited many M.I.T. clubs, has taken a most active part in two Regional Conferences – one in Tulsa on February 2, and the other in Chicago on February 16 – and has been a most effective emissary for the Institute at the "M.I.T. Week End in Havana" toward the end of February, and the "Ninth Annual Fiesta" in Mexico City in mid-March. In addition, he has been a most effective member of the M.I.T. Corporation and richly deserves our thanks.

To follow precedent, let me first report briefly on gifts, finances, and placement. This year, total gifts and bequests will exceed nine million dollars, giving us an average annual gift total for the last five years of $7,500,000 per year.

The book value of our entire invested funds now totals $89,000,000, up $6,800,000 over last year. The market value stands at $129,700,000. We are presently earning 6.27% on the book value of our invested funds. Despite this gratifying increase in endowment, the Institute's endowment on a per-student basis is still about half what it should be, and we have no margin for growth. I do report with pleasure that we will end the year with a balanced budget.

Demand continues high for our students. The mean of the salaries offered bachelor's this June is about $470 per month base pay; for master's, $565; and doctor's degree graduates have ranged from $625 to $875.

And now with these vital statistics recorded, let me turn to other matters.

Several weeks ago, the College of William and Mary held a convocation in honor of William Barton Rogers, its distinguished alumnus who was M.I.T.'s first president. The occasion of this convocation was the 75th anniversary of Rogers' death. He collapsed and died on May 30, 1882, while addressing the Institute's graduating class. Today it is appropriate that we at M.I.T. note this anniversary and pay *our* tribute to the educational innovator and pioneer who founded this institution, defined its special mission, and endowed it with the philosophy, and personality, and form which characterize it today.

The founding of M.I.T. came about, in part, as a protest against the rigidities, the frozen classical formulas of then existing institutions. It came about in part as a response to new needs of an evolving industrial society. In part, it was an expression and projection of Rogers' clairvoyant reading of the future, the place that science would have in this future, and the new mode of education appropriate to this future.

It is important to M.I.T.'s present and future for us to keep clearly in mind these influences and breakthroughs in its past. We should regularly ask ourselves whether we still have the courage and imagination to innovate and to break with tradition. We should be watchful that we do not become the

In recounting Technology's progress in the past year, President Killian also establishes program for M.I.T.'s future.

prisoner of a rigidity and classicism of our own making. We should keep always before us as an ideal Rogers' vision of education constantly anticipating and adjusting to the needs of the future rather than being geared to a society that has been left behind. An institution such as M.I.T., if I may paraphrase Alfred North Whitehead, preserves its vigor so long as it harbors a real contrast between what has been and what may be; and so long as it is nerved by the vigor to adventure beyond the safeties of the past.

These reflections about our past and about our founder and his spirit lead us naturally and forthwith to a discussion of our institutional future. How can we continue to venture beyond the safeties of the past? How can we continue to exhibit the boldness and foresight of Rogers?

These questions are particularly apt since M.I.T. will soon reach its 100th birthday, that milestone occurring in 1961, a short four years away. Plans are already afoot to make this a memorable milestone, thanks to a committee under the chairmanship of John J. Wilson, '29, and I call now on all parts of the M.I.T. family to begin preparations for this celebration. I submit, however, that the most telling way to make this occasion meaningful and important will be for us to move ahead on every front during the next four years so that we may celebrate our 100th birthday with a sense of new accomplishment and heightened effectiveness, and with the satisfaction of feeling then that M.I.T. is ready for a second hundred years, a second hundred years greater even than its first.

As we begin now to ready M.I.T. for its second hundred years, what are some of the tasks we must accomplish and what are some of the evolving needs of our society that we must seek to meet? Of the many, let me suggest ten as typical of the opportunities ahead.

Item number one is the opportunity to make important new advances in engineering education. I am convinced that here M.I.T. has one of the greatest educational opportunities in its history. Our advancing industrial society in the United States, together with our world responsibilities, now require of our engineers a new order of professional excellence, breadth, and versatility. Our nation asks of its engineers that they be more than technicians or narrow specialists, that they henceforth have a deeper grasp of the scientific principles and concepts fundamental to their understanding of nature and a broader foundation of liberal education fundamental to their understanding of man.

In the second half of the last century, when men like Rogers were establishing engineering education in the United States, engineering schools were characterized by bold educational experimentation and innovation. In the first half of this century, while growing in competence and skill, our system of engineering education in the United States, except in a few specific fields, was less responsive to change.

Today there is a renaissance and M.I.T. is leading it. The changes which are taking place include the introduction of more basic science, the realization that professional competence can no longer be acquired by undergraduate study alone, earlier introduction of professional subject matter in the undergraduate curriculum, a recognition that new engineering sciences now require formulation and greater emphasis on graduate study.

Philip M. Morse, left, will direct the new Computation Center which, in a way, is modern counterpart of the differential analyzer developed by Vannevar Bush, '16, (with glasses). President Killian joins in dedication ceremonies as Thomas J. Watson, Jr., right, pushes button putting computer into official operation.

Item number two is the opportunity before us at the Institute to break new ground in undergraduate education. I believe that a strong undergraduate program is an essential part of M.I.T.'s mission and that in the future we should be as innovating and pacesetting in this part of our program as we have been in the past and as we have been in recent years in graduate education. This undergraduate program should have academic standards as high as can be found in any educational institution. It should take full advantage of our opportunity to educate men and women who understand both the liberal and the practical significance of science in our society, whose education is adequate for modern social needs, both with respect to its high scientific and technical level and with respect to the breadth of knowledge and interest it engenders.

In his stirring Arthur D. Little lecture last month, Edwin H. Land, Fellow of the School for Advanced Studies, placed persuasive emphasis on the opportunity which great universities have, really to break with old patterns and to give full opportunity to the latent creative capacities of their students. Young people, he said, come to college harboring within themselves an aspiration toward excellence or greatness, and too often this image is blurred by their experience in college and they discouragedly accept lesser goals for themselves. At M.I.T. we possess one of the most highly selected student bodies in the world, made up of students competitively picked from all over the world. To cite one bit of evidence, if we add together the recipients of national scholarships and fellowships given by National Merit, General Motors, and the National Science Foundation, we find that more recipients elect to study at Harvard and M.I.T. than any other institutions. As one of our

Faculty members has remarked, we have a breathtaking opportunity to achieve a really close impedance match between this great student body and our great Faculty, to make available to our undergraduates in greater degree the stimulus, the imaginative leadership, and the example of excellence presented by men who are outstanding not only as teachers but in their professional accomplishments.

A university has many functions. As Woodrow Wilson once said, it must serve the nation as its organ of recollection, its seat of vital memory. Through its creative activities, it is one of the major means for shaping the nation's future. But it has another vital function, and this it especially performs at the undergraduate level. It should be a bureau of standards for its students' sense of excellence, their taste and their values. We should be able to say of every great college, to use a line from Robert Frost, "it asks of us a certain height." This I hold to be one of the prime responsibilities of our undergraduate program at M.I.T.

Engineers Need More Science

Item number three is the need to find a solution to the increasing demand on the part of our engineering students for more science. Increasingly, large numbers of these engineering students wish to and are encouraged to study physics and mathematics three or four years or more. Inevitably the rank and file of engineering undergraduates will require on the average three years of physics and mathematics rather than the two now prescribed. This is a highly desirable trend, but it imposes severe teaching burdens on our School of Science which we have not yet adequately found a way to meet. Especially do we need to find the funds to handle this teaching load and opportunity effectively. This is but one of the unfolding needs we have in our flourishing School of Science.

Item number four in this program for getting ready for the second century is the need to round out the program of our School of Humanities and Social Studies. In recent years, as you know, we have extended and deepened our curriculum and resources in this School, and our undergraduate program has commanded attention and admiration throughout the academic world. Now, in order to realize fully on this program, to stabilize and insure its high quality, and to bring the School to full maturity, we seek to continue the evolution of a School of true professional status and to develop first-rate new programs in the fine arts and political science. Perhaps ultimately we may wish also to add a strong program in the history of science and technology.

Item number five is the exciting opportunities opened up by our School of Industrial Management which Alfred P. Sloan, Jr., '95, founded. This spring we held a highly successful convocation marking the fifth anniversary of this School and pointing up the power and potential inherent in a wedding of technology and management. By our hundredth anniversary we can forecast that this new School will have realized the great promise of its first five years, not only in terms of its own professional program but in terms of its interrelations and influence with other schools of the Institute. Already, M.I.T. engineering students are choosing more management subjects as professional electives in engineering courses, and there are emerging opportunities to formulate new courses and research programs which achieve an amalgamation of the engineering and management points of view. Already the School of Industrial Management and the School of Humanities and Social Studies work closely together, but out of this symbiotic relationship are appearing new opportunities for each to strengthen the other and for our total effectiveness in social studies to be substantially enhanced.

Item number six is the exceptional opportunity that we have at the Institute to prepare graduates for foreign service, especially in engineering. The United States needs more professional men who have the understanding and orientation to accept assignments in foreign service both for industry and for government agencies operating internationally. The resources of our Center for International Studies afford a first-rate opportunity, if we can exploit it, to introduce a selected number of engineers to foreign studies and to give many more a better understanding of foreign affairs and peoples. Perhaps the greatest shortage we have in the United States today, greater even than the scarcity of scientists, is professional men who have the orientation and preparation to represent this nation effectively in operations abroad.

Item number seven is the need to care adequately, through our School for Advanced Study, for the growing demand for postdoctoral study at the Institute and to make adequate provision for an increased number of visiting scholars.

Item number eight is to create, in our flourishing School of Architecture and Planning, a program of urban studies and research which can contribute toward a better understanding of the problems involved in rebuilding and replanning our cities to cope with congestion, decay, and the great impact of population growth.

Ninth in this list of opportunities and needs is a program to make our dormitories more effective components of our over-all educational program. Last year I reported on the recommendations of the Ryer Committee on the development of our dormitory system. These recommendations, plus other plans under development by the Office of the Dean of Students, are directed toward searching out new ways to make the dormitories realize their full potential as the "Sixth School" in our educational program at the Institute. Especially do we wish to find the means to increase the number of Faculty residents in the dormitories and thus to achieve our own indigenous version of a tutorial plan.

In connection with our athletic facilities, I am happy to be able to report to you that the Institute started construction this week on twelve new tennis courts, six fast-drying ones for match play and six all-weather ones. Arrangements have been made for M.I.T. to buy the Cambridge Armory from the National Guard and we shall use this new acquisition as a gymnasium. I am also glad to be able to report to you that ground will be broken, probably

(Continued on page 552)

Cardinal and Gray

A TECHNOLOGY REVIEW REPORT

CARDINAL events and graying Alumni were much in evidence as the school year came to a close at Technology. To the usual activities of Commencement Day and Alumni Day a number of innovations were added this year. The Institute now has a mace for use on ceremonial occasions; a gift from the Class of 1907, it was designed and made by Leverett H. Cutten, '07. The new Karl Taylor Compton Laboratories were dedicated, the Computation Laboratory was put into operation, and a nuclear reactor under construction was visited. A special feature of Alumni Day was a concert by the Boston Pops Orchestra in Kresge Auditorium to conclude the day's events in appropriate tone.

Events of Senior Week

As usual, the events of Senior Week initiated the activities at the end of the school year which culminated in Commencement Day, June 7, and Alumni Day, June 10. Following completion of their final examinations, members of the Class of 1957 held their Senior Class Banquet in Rockwell Cage, beginning at 6:30 P.M. on Friday, May 31. The Senior Class Party was held in the evening of Saturday, June 1, and Sunday was "M.I.T. Night" at the Boston Pops Orchestra, where members of the Class of 1957 went to Symphony Hall for the light and spirited music for which Arthur Fiedler has won renown. On Monday evening, members of the graduating class left Rowes Wharf for the Senior Class moonlight cruise. Tuesday evening, June 4, the Class held its annual commencement formal ball at the Sheraton-Plaza Hotel in Boston. The remaining events of Senior Week were given over to R.O.T.C. Commissioning Exercises, and the Baccalaureate Service on Thursday, June 6, and to Commencement on Friday, June 7. Thus ended an active round of social activities in which, for the last time, members of the Class could be sure of seeing their classmates as an entire group in full strength.

Time Capsule

At 2:00 P.M. on Wednesday, June 5, President James R. Killian, Jr., '26, assisted by Professor Harold E. Edgerton, '27, of the Department of Electrical Engineering, deposited a "time capsule" in a concrete protective container in the ground adjacent to the Karl Taylor Compton Laboratories. The time capsule was planned and prepared by Professor Edgerton as a means of acquainting future generations with our way of life in 1957. The time capsule, about 10 inches in diameter and about 24 inches long, contains instructions not to open it before the year 2957. The capsule is made of glass and articles contained in it are sealed in a protective atmosphere of argon. Also in the capsule is a small bottle of radioactive carbon 14, with a half life of 5,600 years. The amount of radioactivity has been calibrated and marked on the bottle. When the capsule is opened 1,000 years hence, the reduction of radioactivity can be accurately measured.

The capsule contains writings of the late Karl Taylor Compton, a cryotron, a tonic bottle (empty), a mug, five mint coins placed in a plastic cube by the First National Bank of Boston, documents, scientific relics, copies of Boston newspapers, and other items giving some idea of the status of technology

Students, Alumni, Corporation, Faculty, Staff, and guests are represented in these two views made at year-end activities. Certificate of Honorary Membership in the Alumni Association is presented to Miss Olive Barnard by President Theodore T. Miller, '22. ▼

Mrs. James R. Killian, Jr., John W. Gardner, Commencement speaker, Malcolm M. Jones, '57, and Vannevar Bush, '16, at Commencement Day luncheon in the Great Court. ►

Pierre Joseph deMarcken deMerken, '57 (extreme left), and brother Louis Marie deMarcken deMerken, '57 (extreme right). Both received R.O.T.C. commissions as well as S.B. degrees at this year's exercises. Center view shows, in reading order: Colonel Charles M. McAfee, Jr., Professor of Military Science and Tactics; Captain Joseph S. Lewis, Professor of Naval Science; Reverend J. Edward Nugent, and Reverend Robert C. Holtzapple, Religious Counselors; and Colonel Harmon Lampley, Jr., Professor of Air Science.

and science as of the year 1957, when the capsule was deposited.

The idea of the time capsule occurred to Dr. Edgerton in recent visits to Greece and other Mediterranean countries where it was customary to deposit material for the edification of generations to come, long after buildings and other physical structures had vanished.

R.O.T.C. Commissioning Exercises

Joint Commissioning Exercises for the Institute's Reserve Officers' Training Corps were held on June 6 at 10:30 A.M. in Kresge Auditorium. As they have done so well in the past several years, the Needham High School Band provided stirring band music on this important occasion, and they performed magnificently. The Reverend J. Edward Nugent, Religious Counselor at M.I.T., opened the exercises with an invocation.

Speaking on behalf of the Institute, J. A. Stratton, '23, Chancellor, welcomed the guests and extended to them greetings from President Killian, the Corporation, and the Institute Faculty. Dr. Stratton said the Institute was proud to acknowledge its debt to the defense of this country, and he recalled that, in two World Wars, the Institute had played an important role, not only in training men for military assignments, but also in conducting key research for various national defense projects.

In connection with the Institute's contribution to national defense, Dr. Stratton mentioned particularly the work of the Instrumentation Laboratory, under direction of Professor C. Stark Draper, '26, which may well be regarded as a key to the guidance and control of our current missile program. Dr. Stratton also mentioned the tremendous contributions to national defense being made at the Lincoln Laboratory, especially with regard to early warning systems against enemy aircraft. But he also added that individuals of the Institute's Faculty and staff are making contributions as well, in the conduct of research projects, in serving on various committees, and in conducting consulting activities.

The light-hearted brigade of 1957 charges for diplomas.

Speaking of the assembled cadets, Dr. Stratton expressed pride in those about to receive R.O.T.C. commissions. These future officers, he said, have demonstrated abilities as leaders and have completed a rigorous program of study. "We have every anticipation and every right," said Chancellor Stratton, "to expect that these young men will serve their country well in the future."

Dr. Stratton introduced the guest speakers representing the three branches of the Armed Forces: Major General Edward H. Underhill, Commanding General of the Eastern Air Defense Force who addressed the cadets on behalf of the Air Force; Brigadier General Charles C. Calloway, Commanding General, Quartermaster Research and Development Command who addressed those receiving commissions in the Army; and Rear Admiral John A. Snackenberg, Commandant of the First Naval District. Since the Naval R.O.T.C. unit at M.I.T. is but one year old, no commissions were awarded in the Naval Reserve.

General Underhill's message was addressed primarily to the cadets, rather than to the parents and guests who took part in these ceremonies as spectators. All of us are aware, said General Underhill, of the present extremely critical international political situation. We are assembled here primarily because of this unfortunate state of affairs. But we are also assembled because recent changes in the weapons of war place new and increased responsibilities on those engaged in the Nation's defense. There is now no geographical barrier to air power. We – and our enemies – can strike anywhere in the world where force is needed. But this does not eliminate the problem of personnel. The Air Force needs good and thoroughly trained leaders with backgrounds in technology if we are to have a professional fighting force in being.

James M. Barker, '07, member of the M.I.T. Corporation, gives some good advice to the graduating class on behalf of the 50-year class. Urging the new graduates to view problems broadly, Mr. Barker also attacked the "us - engineers - don't - need - no - English" concept and admonished graduates to master the English language.

Theodore T. Miller, '22, leads Commencement procession followed by Reverend George O. Ekwall, '18, who gave the invocation, and John W. Gardner, Commencement Speaker.

The United States desires to have and maintain a professional force adequate for our defense needs, but the fulfillment of this object by means of modern weapons places heavy demands on all of us.

General Underhill then outlined what the Air Force could offer those who entered its service. It offers hard work, much responsibility, opportunity to use initiative and one's professional training, and it provides satisfaction for doing the tasks that need to be done. Moreover, General Underhill said, the Air Force offers membership in a fine organization.

But the requirements of the Air Force are equally severe. The Air Force expects its officers to accept heavy responsibility; it expects them to use their brains and to show initiative. It also demands a great deal of loyalty. It needs – and wants – those persons who show these attributes and who wish to be part of a fine organization. But it has no interest in recruiting those who do not have such characteristics. Finally, General Underhill (who attended classes at M.I.T. as a student in the Lowell Institute School) congratulated those cadets who were about to receive their commissions.

Speaking on behalf of the Army, General Calloway, 32 years a soldier, expressed the belief that the Nation as a whole recognizes that the military forces must became an indispensable part of our way of life as this is now molded by international events; there will be fearful consequences otherwise. The United States is, by nature, a peaceful and peace-loving nation. For this reason we have, in the past, tended to regard the military services somewhat indifferently. As a result, we have been caught unprepared in a number of crucial periods in our history, including our forced entry into two world wars. He mentioned General Maxwell Taylor's observation that, although the sad, treacherous events of Pearl Harbor left us with a determination not to allow repetition of the unpreparedness with which the Japanese attack found us, we still were not ready for the Communist invasion of Korea in 1950.

General Calloway remarked that the present threat to the United States – and the Free World generally – was clear for all to discern, and reminded the audience that unpreparedness in any future war would have vastly more drastic consequences than anything possibly could have had in the past.

The deterrent to future war is a show of real military strength, said General Calloway. We cannot bluff or make threats we do not intend to carry out. In one way, the gathering in Kresge Auditorium is a military conference which helps to assess our need for national security through build-up of the Reserve Officers' Training Corps.

Finally, in addressing the cadets, General Calloway congratulated them for having done their work at the Institute and in the R.O.T.C. program well, and reminded them of the great opportunity to serve the United States as they become commissioned officers.

Although the Institute has a Navy R.O.T.C. unit, this has been put into operation only last fall and, accordingly, no Navy commissions were awarded. However, the Institute was pleased to have the Navy represented in these exercises by Rear Admiral John A. Snackenberg, Commandant, First Naval District.

Admiral Snackenberg expressed his happiness at the opportunity to say a few words to the R.O.T.C. Class of 1957. He stated that a word we are hearing with increasing frequency is that of "survival." We tend to think of survival in the sense of mere existence, rather than that of outlasting or outliving something or some group of persons. But it is essential that we outlive and outlast Communism, if the Free World is to last. Thus, survival comprises our major objective, and our system of government must outlast and outlive that of Russia.

Whether we shall survive, and how well we can, depends in substantial measure on the young men who now constitute our defense team. It is clear that our military forces can help solve the problem of survival, and the young men, such as those who receive their commissions this year, will be of incalculable assistance in achieving this end.

Admiral Snackenberg reminded his audience that Reserve officers have great responsibility, for the United States places great reliance in having a large corps of Reserve officers. The need for citizens of the United States to serve their country is not a new one;

Honored guests at the head table at the President's luncheon, in reading order, were: Bryant Nichols, '07; Miss Stephany Gardner; Malcolm M. Jones, '57; Mrs. George O. Ekwall; J. A. Stratton, '23; Mrs. J. R. Killian, Jr.; John W. Gardner, Commencement speaker; and President James R. Killian, Jr., '26.

it was anticipated by President Washington who recognized the need for each person receiving the benefits of the Nation, to serve it in some capacity.

In becoming members of the Armed Forces, Admiral Snackenberg reminded the cadets that they would be serving in a great and ancient tradition. The Army and Air Force will expect significant deeds from those who receive their gold bars at the Commissioning Exercises; in a relatively short time, the Navy too will graduate members of the Reserve Officers' Training Corps. Admiral Snackenberg concluded by expressing confidence in those who end their training period this June at the Institute.

The oath of office was administered to the cadets by Colonel Harmon Lampley, Jr., Professor of Air Science. Colonel Charles M. McAfee, Jr., who leaves his M.I.T. post as Professor of Military Science to take up new duties as executive officer in Hawaii this summer, assisted in presenting the commissions. General Underhill then presented each man with his commission as second lieutenant in the Air Force, and General Calloway presented commissions in the Army Reserve. At this time 91 Army, and 27 Air Force Cadets received commissions. In addition, 31 in the Class will receive Army commissions and 12 will receive Air Force commissions by summer's end.

The Needham High School Band then played the National Anthem, and the Commissioning Exercises were concluded with the benediction given by the Reverend Robert C. Holtzapple, Jr., Religious Counselor at M.I.T.

As the cadets – now commissioned officers in the Reserves – left Kresge Auditorium with their friends and relatives, many a camera clicked on the adjacent green, and a new crop of gold bars could be seen being pinned on the shoulders of more than 100 newly commissioned second lieutenants.

Two brothers, who received their degrees at Commencement Exercises also received commissions at the Commissioning Exercises on Thursday. They are Pierre Joseph deMarcken deMerken, who will enter pilot training upon call to active duty, and Louis Marie deMarcken deMerken, who will enter the Air Force with Engineering Specialties.

Baccalaureate Service

About 2:30 P.M. on Thursday, June 6, members of the graduating class began to assemble in a double column in Briggs Field west of Kresge Auditorium, while parents and friends made the more usual entrance to the Auditorium for the Baccalaureate Service. When students, in caps and gowns, had formed columns, class marshals conducted the graduates into the Auditorium, a few minutes before 3:00 P.M., for the traditional services for those receiving bachelor degrees.

In the organ prelude, David Johnson at the Holtkamp organ played selections by Johann Sebastian Bach, Ralph Vaughan-Williams, and César Franck. The "Festival Processional" by Richard Strauss and the "Solemn Processional" from the Water Music Suite by George Frederick Handel were played as members of the Class of 1957 entered the doors of Kresge Auditorium.

President Killian opened the services with an invocation based almost entirely upon Gilbert Murray's translation of an ancient Greek prayer asking for guidance in moral conduct toward one's fellow man. After the invocation, the audience sang the hymn, "O God, Our Help in Ages Past" by William Croft. The scripture reading was given by Henry E. Salzhauer, President of the Class of 1957. Richard W. Knapp, Class of 1957 Organist, played the "Toccata" from

Honored guests at the President's luncheon on Commencement Day included, left to right: Ray P. Dinsmore, '14; Charles M. Wareham, '16°; Carl L. Svenson, '19; Walter C. Eberhard, '14°; Mrs. Herman Klugman; Herman Klugman°; Miss Olive Barnard°; and Miss Doris Peabody.° Nearby, at right is Arthur L. Townsend, '13,° and F. G. Fassett, Jr. Those marked with asterisk reach retirement status as of July 1.

President Killian (this page) seems to be addressing Dr. Killian (opposite page) at Commencement Day luncheon. Others shown are: James M. Barker, '07, Mrs. J. A. Stratton, Vannevar Bush, '16, Mrs. Theodore T. Miller, Reverend George O. Ekwall, '18, Mrs. Bryant Nichols, and Theodore T. Miller, '22, President of the Alumni Association.

Symphony V, by Charles Marie Widor, as organ interlude.

The Baccalaureate address, entitled "The Stream of Life," was given by George R. Harrison, Dean of the School of Science. The Review is pleased to reproduce this important message to graduates on page 491.

Prayer was offered by President Killian, the audience joined in singing "A Mighty Fortress Is Our God" by Martin Luther, and President Killian concluded the ceremonies with the benediction. The graduates left the Auditorium to recessional organ music which included "Trumpet Tune" by John Stanley, "Processional in G" by John Stanley, and "Processional from Judas Maccabeaus" by George Frederick Handel. The postlude was "Prelude and Fugue in G Minor" by Dietrich Buxtehude.

Commencement

Weatherwise, Commencement Day, Friday June 7, began with a poor start. Early in the morning heavy rain threatened to dampen the holiday spirit somewhat. But by 10:30 A.M. when the Exercises got under way, the sun broke out occasionally, although the sky was still overcast most of the time.

While friends and parents took their places in chairs in the Rockwell Cage, graduates and members of the Faculty and Corporation, along with honored guests, were busy robing in the National Guard Armory. Last minute instructions were given, photographs were made as occasion allowed, until 10:30 promptly, when the procession, led by Class officers, left the Armory and proceeded, under canvas, to the nearby Rockwell Cage. Following the graduates came members of the Faculty, honored guests (including Professors Emeriti, members of the Class of 1907 and officers of the Class of 1932), and finally Theodore T. Miller, '22, Chief Marshal, followed by President Killian, with Vannevar Bush, '16, Chairman of the M.I.T. Corporation, and Chancellor Stratton with John W. Gardner, the day's principal speaker, and the Reverend George O. Ekwall, '18. During the procession, David Johnson played an organ interlude from the organ in Kresge Auditorium, with sound fed to loud-speakers in the Rockwell Cage.

As soon as all had assembled, the Star Spangled Banner was played, and Dr. Bush opened the exercises. The invocation was given by the Reverend George Olof Ekwall, Rector of Christ Church in Waltham, who in 1918 received the S.B. degree in chemical engineering from M.I.T.

The Commencement Address, given by John William Gardner, President of the Carnegie Corporation of New York, aimed to stimulate thinking on means by which we can enhance and further education of superior students while simultaneously providing suitable education at all levels for the advancement of those who, for one reason or another, find their maximum opportunities in fields not best served by universities. The Review is pleased to present Dr. Gardner's thoughts on page 495.

Upon conclusion of the Commencement Address, President Killian awarded the Goodwin Medal, together with certificate and check, to Thomas Greenway Stockham, Jr., '55, graduate student and Teaching Assistant in the Department of Electrical Engineering. Honorable Mention for the Goodwin Medal, named in honor of Harry M. Goodwin, '90, outstanding teacher and first Dean of the Graduate School, went to Jan List Boal, Teaching Assistant in the Department of Mathematics, and to George Arthur

Seated looking toward camera, left to right, are: Walter J. Beadle, '17, Mrs. W. J. Beadle, George Scatchard, Mrs. George Scatchard, Avery A. Ashdown, '24,* Mrs. W. E. Stanley, William E. Stanley,* Mrs. F. G. Fassett, Jr., F. G. Fassett, Jr., and Arthur L. Townsend, '13.* Those marked with asterisk become emeritus professors July 1. At right, D. P. Severance, '38, partly hides G. M. Roddy, '31, President-elect of the Alumni Association.*

Top brass at the Alumni Day luncheon included: D. Reid Weedon, Jr., '41, Mrs. H. E. Lobdell, H. E. Lobdell, '17, Mrs. D. Reid Weedon, Jr., Charles A. Chayne, '19, Mrs. Bryant Nichols, Clarence L. A. Wynd, '27, Mrs. C. A. Chayne, Bryant Nichols, '07, Leverett H. Cutten, '07, Mrs. C. L. A. Wynd, Thomas J. Watson, Jr., and Mrs. John J. Wilson. Other honored guests are at reserved tables, foreground.

Brown, '51, Assistant Professor of Mechanical Engineering. The Goodwin Medal is awarded in recognition of outstanding teaching on the part of young instructors who are continuing their education at the Institute.

Presentation of the degrees was made by President Killian. C. Richard Soderberg, '20, Dean of the School of Engineering, read the names of those receiving degrees in engineering, and George R. Harrison, Dean of the School of Science, read the names of those receiving science degrees. Harold L. Hazen, '24, Dean of the Graduate School, and John T. Norton, '18, Chairman of the Faculty, were Investors of the Hood for doctoral candidates.

After presentation of degrees, President Killian spoke briefly to the parents of the graduates, and Chancellor Stratton gave the charge to the graduates, which Review readers will find on page 496.

Commencement Luncheon

Upon completion of the commencement exercises, members of the graduating class, with families and friends, joined members of the Class of 1907, the Faculty and Administration at the President's luncheon under canvas in Du Pont Court. After a catered luncheon, President Killian made a few remarks addressed primarily to members of the Classes of 1957 and 1907.

President Killian observed that the luncheon provided opportunity to honor two classes – the Class of 1957, which now joins the ranks of Technology Alumni, and the Class of 1907, which returns to M.I.T. for its 50-year reunion. The Class of 1907 provides inspiration, said Dr. Killian, for the graduating class to return to M.I.T. 50 years hence, in 2007.

In giving a salute to these two classes, President Killian envisioned them as symbolizing the wisdom of the older and more mature persons, and the enthusiasm and vigor of youth. In their reunion of the year 2007, the Class of 1957 will probably reminisce, as the Class of 1907 now does, about the difficulty of their studies at the Institute. But there is little of the "rah-rah" spirit about Technology Alumni; rather, said Dr. Killian, there is a sense of professional allegiance and mature fellowship that transcends the "old grad" concept.

In contrast to today, the Class of 1907 was graduated during a depression period. Yet, despite times of economic difficulty, members of this class have achieved high distinction in a wide variety of fields including statesmanship, politics, business, and administration, as well as in engineering and science. As an outstanding example of a member of the class who has achieved distinction in business, Dr. Killian introduced James M. Barker, '07, who spoke to the graduates for the Class of 1907.

On behalf of his Class, Mr. Barker thanked Dr. and Mrs. Killian for the part they were permitted to play in commencement activities. In preparing remarks for the occasion, Mr. Barker said he had tried to place himself in the state of mind his class would have been in had they been asked to listen to a member of the 50-year class when they received their degrees. Unfortunately this was not possible, for there was no Class of 1857; the Class of 1918 was the first class which had opportunity to listen to a 50-year class.

In speaking to the graduates Mr. Barker stressed the prime importance of a mastery of the use of English. A word is a symbol of a thought concept, and most thinking is done with word symbols which represent a shorthand way of thinking. The way words are assembled, said Mr. Barker, gives a clue to the thinking process of those who use words. Thus, if one's expressions tend to be vague and clumsy, there is more than a strong hint that that person's concepts are likely to be foggy and his thinking defective. The only person who is satisfied with vagueness, incom-

General view of portion of tables reserved for honored guests at the Alumni Day luncheon in the Great Court, June 10.

In reading order: John J. Wilson, '29, Mrs. James R. Killian, Jr., Alfred P. Sloan, Jr., '95 (hidden), Mrs. Karl T. Compton, Theodore T. Miller, '22, Mrs. J. A. Stratton, James B. Fisk, '31, Mrs. J. R. Zacharias, J. A. Stratton, '23, Mrs. T. T. Miller, Jerrold R. Zacharias, Mrs. J. B. Fisk, Arthur K. Hunt, '85, and Oscar E. Nutter, '87.

pleteness, or ambiguity, is one who is incompetent, for the man who uses language well is one who is clear in his thinking.

The humanities, too, provide an essential element in one's education. We know, said Mr. Barker, that the world does not progress through science and technology alone. Mr. Barker reminded his audience that Pascal said that it is better to know something about everything than it is to know everything about some one thing. When we see what progress is made in the world, we see that the prizes go to the men with broad and ranging minds. Those who have trained their minds well are interested in life and what life brings; they are not those who encounter boredom upon retirement.

Mr. Barker urged graduates continually to relate their immediate jobs to broader problems and to see the interrelationships and interlinks between the things that are important in the world. One who habitually develops this power of interrelating events will accelerate his progress. The world needs men who know significant relationships; these are the men who secure responsibility for broad planning programs which are usually the most interesting kind of work.

Mr. Barker indicated that he wished to share some of his conclusions on management with members of the Class of 1957. He pointed out that managing enterprises today is quite different from what it had been in the past and stated his own epigram: "We managers manage with the consent of the managed in this modern age. The manager who forgets that principle does so at the peril of his management career."

Most important of all the advice he could give, said Mr. Barker, was to urge graduates to master the basic principles of any operation in which they are engaged from the very first. It is easier to begin with an examination of details, but uncorrelated details without relation to basic principles provide no basis for evaluation. The man who continually deals only with details is lost in a maze of confusion.

As prime example of his meaning, Mr. Barker made reference to the autobiography of the elder Henry Cabot Lodge. In this book, Mr. Lodge speaks of the time when his education had reached the point that he found keen pleasure and stimulation in using his mind. Today's graduates have made a good start in that direction, said Mr. Barker, but they have responsibility for continuing to develop their intellectual abilities. Finally, Mr. Barker concluded by wishing success to the Class of 1957.

As Mr. Barker concluded, rain began to fall, and President Killian urged those at the outer edges of the tents in Du Pont Court to take adequate shelter. President Killian then introduced an eminent man of the Class of 1907 – Bryant Nichols – who took a brief bow amid enthusiastic applause. President Killian then called on Malcolm M. Jones, '57, who had made an outstanding record as an undergraduate, having been on the dean's list six out of eight terms, a member of Tau Beta Pi, president of his fraternity, and a member of the Ryer Housing Committee.

Mr. Jones addressed himself primarily to members of his class and their parents in presenting a brief statistical picture of the graduating class. He recalled that four years ago 803 students had entered as freshmen, but that this original group was reduced to 624 who finished their work and received degrees, so the mortality was about 22 per cent. Originally, members of the Class of 1957 came from every state in the Union except North Dakota, South Carolina, Arkansas, and Nevada. The Class had quite a few foreign students, most of whom came from Canada or South America.

The degrees awarded, said Mr. Jones, will indicate something of the range of interest which the class

Because it started to rain as the Commencement luncheon was concluded, the reception line was held indoors, adjacent to headquarters of the Department of Mechanical Engineering. Receiving are: President and Mrs. Killian, Chancellor and Mrs. Stratton, Dean and Mrs. Rule, Henry E. Salzhauer, '57, and Malcolm M. Jones, '57.

Marshall B. Dalton, '15, presents the Karl Taylor Compton Laboratories to President Killian at dedication ceremonies in Compton Hall, filled to capacity on Alumni Day.

had as undergraduates. As for the future, not all will go into engineering or science by any means. Something like 30 to 35 per cent of the students will continue graduate work. Many of this group will remain at M.I.T. but others will go to Harvard and more remote educational institutions throughout the country. Several will go directly into education, or will take graduate work in preparation for a career in teaching. Some will go into banking, or the medical profession, and others will enter military service. Quite a number will enter employment in foreign lands. While most of these will be employees of domestic firms having offices in foreign lands, some will enter the employ of foreign concerns. At least one member of the class plans to study theology with a view toward entering the ministry.

In conclusion, Mr. Jones stated he had personally gained a great deal while at M.I.T., and he felt sure his classmates felt the same way on this matter as well.

As final event of the luncheon program, President Killian introduced those guests who were retiring as of July 1. This group of 14 persons had given more than 400 man-years of service to the Institute, and President Killian took obvious pleasure and pride in calling on the following to rise: Avery A. Ashdown, '24, Arthur R. Davis, Walter C. Eberhard, '14, Herman Klugman, William H. McAdams, '17, George Scatchard, William E. Stanley, Arthur L. Townsend, '13, Charles M. Wareham, '16, Walter L. Whitehead, '13, Edward L. Cochrane, '20, John J. Rowlands, Olive Barnard, and Doris Peabody.

At the conclusion of these remarks, the luncheon was adjourned. Since it had begun to rain, President Killian announced that the reception line would be held in Building 3 near the headquarters of the Department of Mechanical Engineering. Greeting guests on behalf of M.I.T. were President and Mrs. Killian, Chancellor and Mrs. Stratton, Dean and Mrs. Rule, Henry E. Salzhauer, President of the Class of 1957, and Malcolm M. Jones, President of the Institute Committee of the Class of 1957.

Class of 1932 Reunion

In recounting the events of Commencement and Alumni Day at the Institute, mention should also be made of the reunion of the Class of 1932. With Rolf Eliassen, '32, as chairman, the Reunion Committee planned for their quarter-century gathering to take place, for the most part, on the Tech campus. Baker House — now a student dormitory, but still an open field when the Class of 1932 were students — was the reunion headquarters where registration and social gathering were held on Saturday, June 8. Class picture, taken early on Saturday evening, was followed by reunion dinner at which the address of welcome was given by President Killian. As President of his Class, Thomas E. Sears, Jr., '32, conducted the business meeting in which Donald B. Gilman, '32, gave the Class Gift Committee report and Henry E. Worcester, Jr., '32, gave the report of the Nominating Committee.

On Sunday, Catholic and Protestant services were held in the M.I.T. Chapel, after which members of the 25-year Class took busses for Castle Hill, Ipswich, for a tour of the Crane estate. Those who wished could swim in the Atlantic, a New England shore dinner was provided, and late in the afternoon, busses brought classmates back to Baker House for buffet supper.

On Monday — Alumni Day — members of the Class of 1932 joined other Alumni in the events recorded below.

Alumni Day

Alumni Day — Monday, June 10 — was one of those delightful, warm, sunny, pleasant days James Russell Lowell wrote about in "the Vision of Sir Launfal." Something like 1,300 Alumni returned to Cambridge to take part in the morning symposium, to join in the luncheon at which President Killian gave his annual report, to witness the dedication of the new Karl Taylor Compton Laboratories, to visit the recently completed Computation Center and the nuclear reactor now under construction, to join with their classmates in a social hour on the green adjacent to Kresge Auditorium, to contribute to the good fellowship of the Alumni Day Banquet and finally, to conclude the day with a concert by the Boston Pops Orchestra conducted by Arthur Fiedler.

As they have done for more than a dozen years in the past, returning Alumni registered at booths set up in the lobby of Building 7. The first event of the day was the morning symposium at Kresge Auditorium. Here, with Chancellor J. A. Stratton, '23, presiding, two addresses were given on "Today's Science — Tomorrow's Promise." One of these, emphasizing progress in the communications and electronics fields was delivered by James B. Fisk, '31, Executice Vice-president of the Bell Telephone Laboratories. The second by Jerrold R. Zacharias, Professor of Physics,

reported progress on current studies aimed to devise new methods of teaching science, particularly at the high school level.

Those taking an active part in the symposium met in one of the rehearsal rooms of the Kresge Auditorium for informal social gathering – with coffee – prior to the presentation of addresses which occurred at 10:00 A.M.

In opening the symposium, Chancellor Stratton expressed pleasure at opening Alumni Day events. The somewhat serious tone of the morning symposium would be relieved by lighter fare in the evening. The symposium, said Dr. Stratton, has grown out of many years of experience in holding Departmental conferences, and later Regional Conferences, at which the aim was to bring to Alumni something of the progress being made in important areas of scientific and technological progress. These conferences represent one way in which M.I.T. can bring to Alumni recent progress in technology. The hope is to stimulate the audience, for too much occurs these days to expect that any significant progress in science education might be achieved in a single day.

Today, said Dr. Stratton, we have selected for discussion two topics close to the heart of the last President – Karl Taylor Compton – recent advances in the field of physics, and techniques for increasing the effectiveness of teaching methods for young people. Dr. Stratton then introduced James B. Fisk, '31, who spoke on the first of these topics. Dr. Fisk's able address will be found on page 497 of this issue of The Review. The second symposium address, by Professor Zacharias is presented for Review readers on page 501 of this issue.

Upon conclusion of the second address, Chancellor Stratton took opportunity to express the concern of the Institute's Faculty with development of the most effective possible means of instruction, especially at the undergraduate level. Although the Institute has received much publicity for the achievements it has made in research and because of the growth of its body of graduate students, the Faculty is keenly aware that its primary mission is to constantly improve the teaching of its undergraduates.

Alumni Day Luncheon

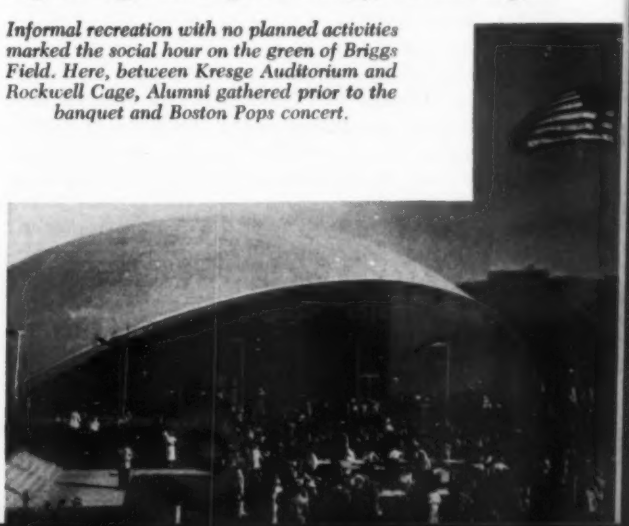
Upon conclusion of the symposium, Alumni gathered in Du Pont Court for the luncheon, under canvas, which has become a high point of the day's activities. As the majority of Alumni served themselves at a catered luncheon and gathered in congenial groups, a score of honored guests, along with more than 100 Alumni and wives who have passed their 50th reunion year, were served at tables specially reserved for them in the main court adjacent to Du Pont Court.

When the mid-day repast was finished, John J. Wilson, '29, Master of Ceremonies and Vice-president of the Alumni Association, opened the business portion of the affair. He was fortunate in being able to open his remarks with comments regarding an unusual gift which the Class of 1907 had made to M.I.T. – a ceremonial mace carried in commencement exercises on June 7 and officially presented on Alumni Day.

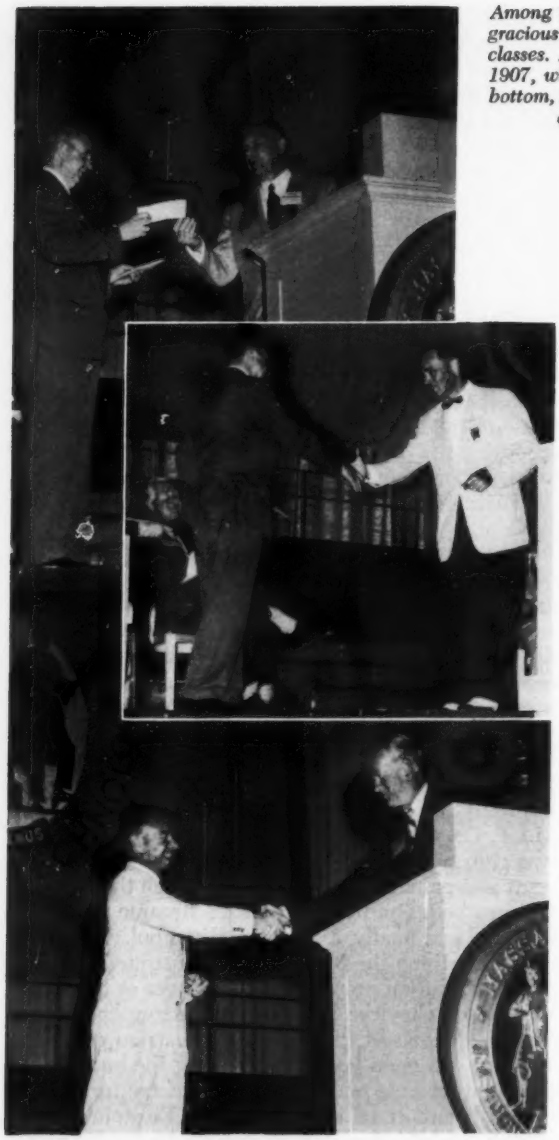
The idea of a mace for M.I.T. developed in 1952, said Mr. Wilson, at the 45th anniversary reunion of the Class of 1907. The Class welcomed this means of making a gift at their 50th anniversary and commissioned Leverett H. Cutten, '07, to design and make the mace. For years, Mr. Cutten had silversmithing as one of his hobbies and is accomplished in sculpturing and drawing as well as in silversmithing. He spent five years designing and planning the mace and, in the past year, has devoted his entire time to this project. The interest and enthusiasm with which Mr. Cutten embarked on this project was ably recorded by Mr. Wilson who read excerpts from letters Mr. Cutten had written to Bryant Nichols, Secretary, Class Agent, Reunion Chairman and Chairman, 50th Anniversary Gift Committee of the Class of 1907. Mr. Wilson also introduced President Killian who, after accepting the mace from Mr. Cutten, was scheduled to give his annual address. Mr. Wilson then asked President Killian and Mr. Cutten to take part in the mace presentation ceremonies.

In presenting the mace, Mr. Cutten remarked that this event could not have taken place 50 years ago, for the Class of 1907 had but very simple and meager commencement exercises, without caps and gowns. Mr. Cutten said he was first inspired to think of a mace for M.I.T. some years ago when he attended commencement exercises at Yale University where a mace was used in the commencement procession. In 1949, Mr. Cutten made a mace for Bates College and five years ago suggested that such a ceremonial symbol would be appropriate for the Class of 1907 gift to M.I.T. Originally, said Mr. Cutten, the mace was a war club with radial flanges at one end with coat of arms and pommel at the other, by which this weapon was grasped. Gradually, the mace became a weapon of guard and finally, a ceremonial symbol.

In describing the M.I.T. mace (illustrated on page 479), Mr. Cutten pointed out the beaver at the top of the head; below the head are three large knobs containing symbols of the work being carried on at the Institute. An open book, representing the humanities, the right-triangle of Euclidean geometry for mathematics, symbols of the atoms and Einstein's mass-energy equation for physics, doric columns for architecture, transit for civil engineering, two enmeshed gears for mechanical engineering, turbine blades for hydraulics, anchors for naval architecture and marine engineering, microscope for biology, coil and magnet



Informal recreation with no planned activities marked the social hour on the green of Briggs Field. Here, between Kresge Auditorium and Rockwell Cage, Alumni gathered prior to the banquet and Boston Pops concert.



Among the last events to take place at the Alumni Day banquet was the gracious acceptance by President Killian of gifts from the 25- and 50-year classes. At top, Bryant Nichols hands Dr. Killian check for the Class of 1907, while Thomas E. Sears, Jr., does likewise for the Class of 1932. At bottom, Theodore T. Miller, '22, turns over the reins of the Alumni Association to G. M. Roddy, '31, who becomes president July 1.

for electrical engineering, and wing section for aeronautics were cited as symbols engraved on this part of the mace. At the lower end, said Mr. Cutten, is a sphere with acorn and oak leaves, and the M.I.T. seal, together with inscription as gift to M.I.T. from the Class of 1907.

At the conclusion of this description of the mace, Dr. Killian thanked Mr. Cutten and his class for the splendid gift which was accepted as a token of the interest and ability of members of the 50-year class, and as permanent reminder of the loyalty of the Class of 1907.

President Killian then gave his annual report to Alumni. In this, Dr. Killian listed ten important objectives for M.I.T. to work toward in the immediate future. In emphasizing the need for raising funds for endowing Faculty salaries, he announced that a fund for $5,000,000 was being raised for this purpose, and that Alfred P. Sloan, Jr., '95, had agreed to underwrite one fourth this amount provided the remaining three fourths came from other sources. Dr. Killian announced that $1,000,000 of the required $3,750,000 had already been promised. Readers of The Review will find the full text of Dr. Killian's annual report on page 504 of this issue.

Mr. Wilson concluded the luncheon by announcing that the mace would be on display in Du Pont Court for the next several hours, and by calling attention to the next item on the day's program – the dedication of the Karl Taylor Compton Laboratories.

Dedication of Compton Laboratories

At 2:30, several hundred persons gathered at the Karl Taylor Compton Laboratories to dedicate new M.I.T. laboratory and teaching facilities. Vannevar Bush, '16, Chairman of the Corporation, opened the meeting which was so well attended that not all who came could be provided with seats. Dr. Bush reminded the audience that the dedication ceremonies were an occasion for joy as well as sadness. "We are saddened by the fact that a former president and beloved colleague is no longer in our midst," said Dr. Bush, "but we can rejoice in the knowledge that the kind of building being dedicated is just the type which Dr. Compton himself would want to see rise at the Institute."

In presenting the new facilities to M.I.T., Marshall B. Dalton, '15, recalled the origin of the Compton Laboratories. President Compton had made tremendous contributions in building M.I.T. pre-eminence in physics, and especially in electronics and nuclear science. But despite his great contributions, no permanent structure existed as a reminder of Dr. Compton's service. The inspiration for a laboratory of nuclear science and electronics to honor Dr. Compton came from Alfred P. Sloan, Jr., '95. It was Mr. Sloan's encouragement and generosity, aided by that of the Corporation, that made the new laboratories possible. Mr. Dalton then presented the new buildings to Dr. Killian as a memorial to Karl Taylor Compton.

Dr. Killian remarked that the occasion was one for celebration, tribute, and appreciation. The need for laboratories such as were dedicated on June 10, was clear a decade ago, but no means were then available for building the necessary structures, which will be shared by both the Research Laboratory of Electronics and the Laboratory for Nuclear Science. Dr. Killian reminded the audience that the Research Laboratory of Electronics was an outgrowth of the war-time Radiation Laboratory which, under the direction of Dr. J. A. Stratton, '23, and later J. B. Wiesner, has carried out in peacetime many important research projects similar to those conducted by the Radiation Laboratory during World War II. The Nuclear Science Laboratory is a new postwar activity and is not an outgrowth of earlier war-time facilities at M.I.T. Under the direction of Jerrold R. Zacharias and now Martin Deutsch, '37, first-rate

(Continued on page 518)

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CARDINAL AND GRAY

(Continued from page 516)

work in the field of nuclear science is being undertaken. Both laboratories which will occupy the new building have the whole-hearted support of the nation's Armed services.

There is appreciation on the part of the Faculty and students, said Dr. Killian, for the financial aid that has come from Alumni and industry. Alumni have furnished two rooms in the Laboratories – the John Picker Kolker Room was given by Leon A. Kolker, '31, in memory of his son. The other room was donated by George E. Merryweather, '34, in the name of his Cleveland firm, the Motch and Merryweather Machine Company. Substantial support has also come from Du Pont, Webster, and Kresge Foundations. Special salute and thanks were given to Alfred P. Sloan, Jr., '95, whose gift of $1,000,000 was exceeded by the many contributions in the thought and energy he gave to the building.

The laboratory does contain one facility not fully envisioned when plans for the Compton Laboratories were begun – a new center of computation. Philip M. Morse, Professor of Physics, recognized the Institute's needs for such a research center and urged M.I.T. to work toward the establishment of new computational facilities of the type represented by the differential analyzer and the Whirlwind digital computer developed at the Institute. President Killian was pleased to report that M.I.T. had found generous friends when in need, and a discussion of the Institute's aims, with Thomas J. Watson, Jr., President of International Business Machines, Inc., led to the I.B.M. grant of a 704 computer.

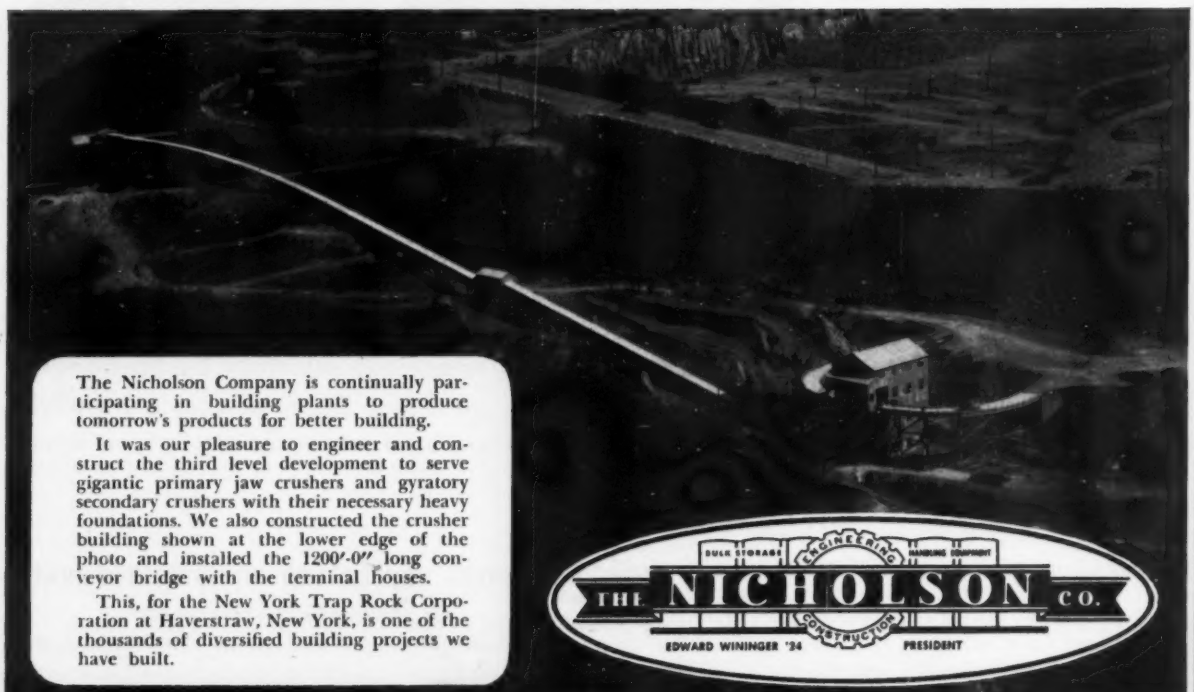
As for the building itself, it represents a nine-million-dollar tribute to Karl Taylor Compton. Many of the Institute's Faculty have had a hand in planning it, and Dr. Killian singled out for special mention, Gordon S. Brown, '31, Head of the Department of Electrical Engineering; Nathaniel H. Frank, '23, Head of the Department of Physics; George G. Harvey, Henry J. Zimmermann, '42, Peter T. Demos, '51, Frederic J. Eppling, '47, Frank M. Verzuh, '46, among others. The building was constructed by Skidmore, Owings and Merrill, and Gordon Bunshaft, '33, of that organization played a most helpful role in its design. Dr. Killian expressed appreciation for all who have helped to build the new facilities, and the building was accepted as a means of furthering the aims and objectives of the professional life of Karl Taylor Compton.

Dr. Bush then introduced Thomas J. Watson, Jr., President of I.B.M.

Mr. Watson, a member of the M.I.T. Corporation, said he and his firm were proud to be associated with M.I.T. and the Compton Laboratories, although he regarded I.B.M.'s contribution as a small one. Even complex machines, said Mr. Watson, are merely tools of men to be used by men in their creative work. The machines have no inherent creative ability. But they

(Continued on page 520)

MATERIALS FOR THE CONSTRUCTION OF TOMORROW



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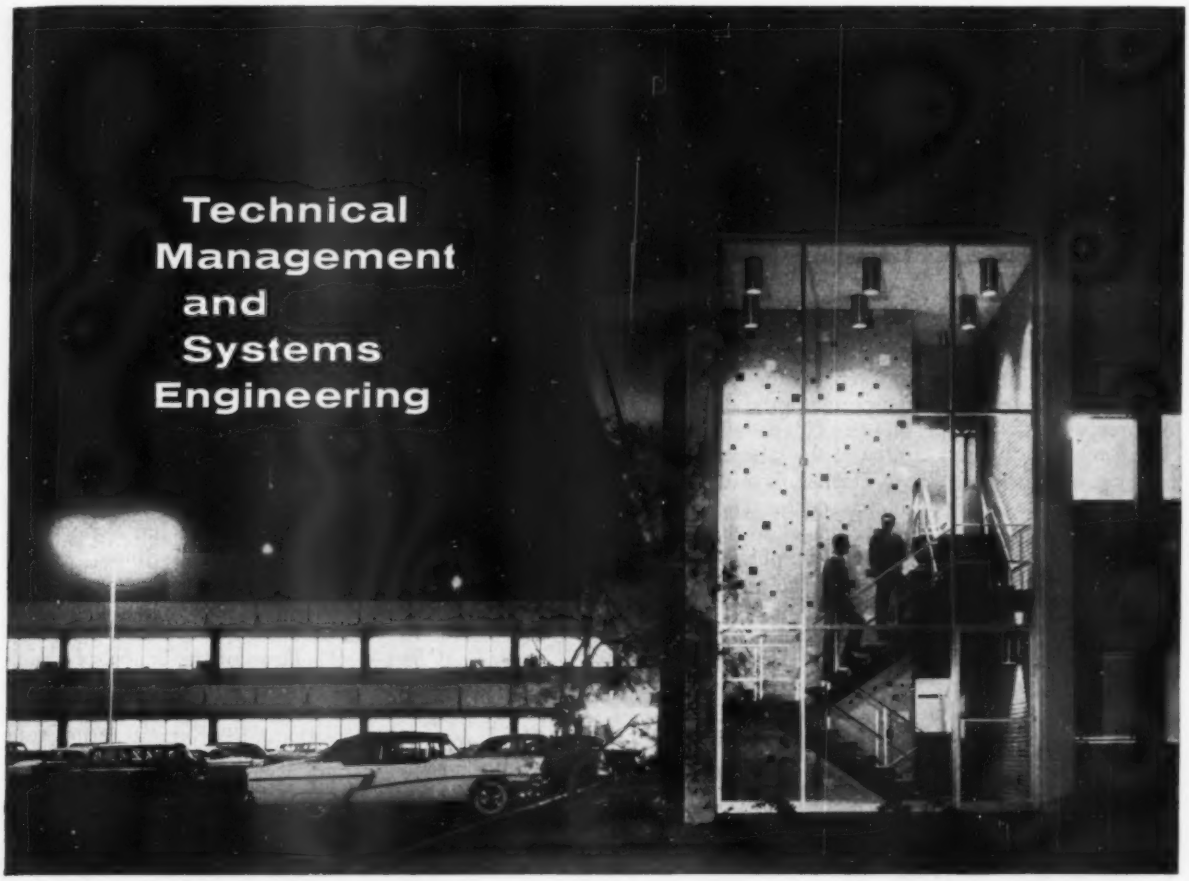

In systems engineering work, it is necessary to bring together a team that includes scientists and engineers of a wide range of technical specialties. In major weapons-systems projects, such teams will include hundreds of scientists and engineers.

But the assembly of a large group of scientists and engineers, no matter how capable they may be individually, does not of itself ensure good systems-engineering performance. The caliber of the project management has a major effect upon its technical accomplishment. It is not easy to coordinate the activities of large numbers of scientists and engineers so as not to stifle their creativeness on the one hand, nor to permit the various development sub-efforts to head toward mutually incompatible objectives on the other.

Of primary importance for good systems management is the philosophy underlying the selection of the supervisory personnel. The head of a technical activity should, first of all, be a competent scientist or engineer. A common mistake — nearly always fatal in systems work — is to fill such positions by non-technical men who have been trained only in management techniques. In the highly complex activities of major systems work, what is required is *technical management*, and of the two words, the word *technical* must never be overlooked.

In the selection of scientists and engineers for technical management, it is essential that the men chosen be broad in their training and approach. Each principal department head, for example, must have a good basic understanding of the technical facts of life of the other departments. When these people get together they need to speak a common language and understand each other's fields, so that proper decisions can be made on the many interrelated problems that come up. The higher the organizational responsibility of a technical manager, the more important this factor becomes.

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CARDINAL AND GRAY

(Continued from page 518)

can increase the creative capacity of men who use them, and free the human mind for engaging in original thinking.

Mr. Watson regarded the new computation center as representing a new relation between industry and the university. He paid tribute to the development, at M.I.T., of the magnetic memory core which forms an important element of modern computers. But just as industry turned to the colleges for the memory core, it also turns to the colleges and universities for people as well as for ideas.

Finally, as principal speaker at the dedication ceremonies, George R. Harrison made the dedication address which will appear in the November issue of The Review with a description of the laboratories.

Upon conclusion of Dean Harrison's address, visitors filed to the new computation center where Philip M. Morse, Professor of Physics, spoke on the uses to which the I.B.M. computer would be put. Dr. Morse presented to Mr. Watson a copy of the first year's report of the computation laboratory, and Mr. Watson then pushed a button which officially placed the computer into operation for its intended educational and research purposes.

Nuclear Reactor

Those who wished, had opportunity to visit the M.I.T. nuclear reactor now under construction on Albany Street, west of Massachusetts Avenue in an industrial section of Cambridge adjacent to the main M.I.T. buildings. Those who made this interesting trip had opportunity to hear Manson Benedict, '32, Professor of Nuclear Engineering, report on the purpose and use of the reactor, and also its general method of construction.

Social Hour

Between 5:00 and 6:00 P.M., Alumni with their relatives, friends, and classmates, had opportunity to spend a pleasant hour in the sun on the green of Briggs Field between Kresge Auditorium and the Rockwell Cage, free of speeches or other planned activities.

Alumni Banquet

At 6:00 P.M., some 1,300 Alumni entered Rockwell Cage for the Alumni Banquet which has always been a highlight of Alumni Day. A steak dinner, catered by Seiler, was served amid pleasant conversation.

At 7:00 P.M., Theodore T. Miller, '22, conducted the brief business affairs of the evening. He called upon E. P. Brooks, '17, Dean of the School of Industrial Management, to conduct Miss Olive Barnard to the stage for induction as an honorary member of the M.I.T. Alumni Association. Miss Barnard retires from her post as administrative assistant in the School of Industrial Management after many years of close as-

(Continued on page 522)

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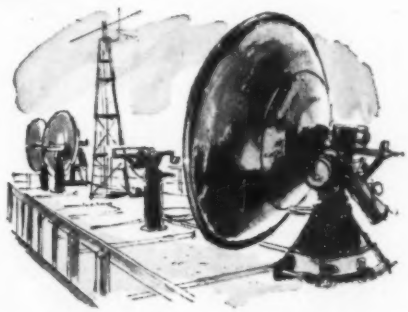

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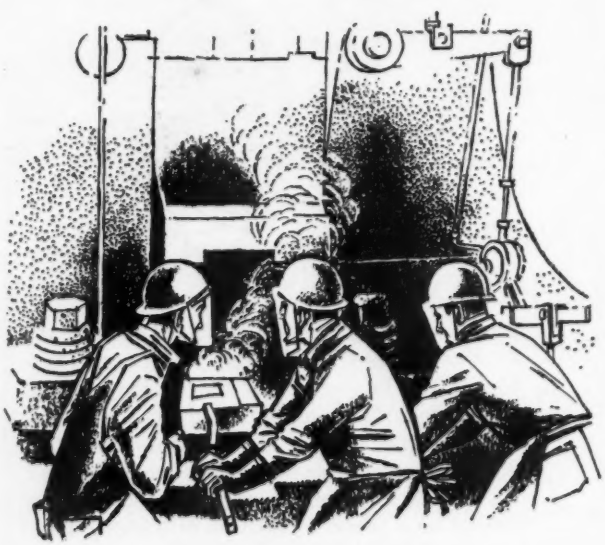

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CARDINAL AND GRAY

(Continued from page 520)

sociation with Professor Erwin H. Schell, '12, and students of Course XV. Mr. Miller, himself a graduate of Course XV, took obvious pride and pleasure in handing Miss Barnard her certificate of membership and in recalling her extraordinary ability to remember faces and names of former Course XV students.

Class gifts totalling $110,000 were then presented to President Killian. Thomas E. Sears, Jr., President of the Class of 1932, presented a check for $45,000 from the 25-year class. Bryant Nichols, President, Secretary, Class Agent, Reunion Chairman, and Chairman of the 50th Anniversary Gift Committee of the Class of 1907, made the presentation of $65,516.30 on behalf of the 50-year Class, in verse.

In his gracious acceptance of these Class gifts, President Killian reminded the audience that both classes had graduated during periods of financial depression. Yet, they had managed to make their own high marks in the world despite the difficulties of the periods in which they were graduated.

Mr. Miller then briefly summarized some of the Alumni activities in which he had played a major role in the past year as president of the Association. The Alumni Association, said Mr. Miller, has engaged in at least five major fields of activity, each of high importance. (1) It helps develop and maintain bonds of loyalty and friendship among Technology Alumni. (2) It serves an important purpose in informing Alumni and the public about M.I.T. (3) It is an important and active element in the financial support of M.I.T. objectives. For example, this year again the Alumni Fund exceeds $500,000, according to Avery H. Stanton, '25, retiring Alumni Fund Chairman who, unfortunately, could not be present. D. C. Arnold, '27, President of the Alumni Association in 1955-1956, will serve as Alumni Fund Chairman for the coming year. (4) Important work is also done by members of the Alumni Council at their meetings on the last Monday of the month during the school year, and by those who serve as Honorary Secretaries and Educational Counselors. (5) Finally, Alumni participate actively in the management of M.I.T. itself through serving on the M.I.T. Corporation. Of 60 members of the Corporation, 30 Life Members and 15 Term Members are M.I.T. Alumni.

In conclusion, Mr. Miller acknowledged the effective support he had received during the past year from officers of the Alumni Association, singling out H. E. Lobdell, '17, D. P. Severance, '38, H. B. Kane, '24, and J. E. Conrad, for mention. He then introduced Gilbert M. Roddy, '31, who will be president of the Association beginning July 1, 1957.

Mr. Roddy expressed appreciation at his election to this important post, paid tribute to D. Reid Weedon, Jr., '41, who had been general chairman of Alumni Day, and made two brief announcements. The first was that the evening event, at which Alumni would attend a Boston Pops Concert, represented the first telecasting of this well-known concert; it could be seen and heard on TV Channel 2 from WGBH-TV. The second was that, although attendance exceeded

(Concluded on page 524)

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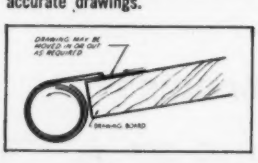

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(Concluded from page 522)

all expectations, ample seating would be available for all who held banquet tickets. Additional seating space for others would also be available in the Little Theatre of Kresge Auditorium for "The Pops."

Boston Pops Concert

Arthur Fiedler, Conductor, and the Boston Pops Orchestra staged a magnificent performance in Kresge Auditorium the evening of Alumni Day. Every seat in the house was a good one, and some Alumni had their first opportunity to witness the unusual visual and acoustic properties of the comparatively new structure. The program for "M.I.T. Night at the Pops" was an unusually good one too, in three parts.

The first part of the program included the Polonaise from "Eugene Onegin," by Tchaikovsky; Suite from "Peer Gynt," by Grieg; Air on the G-String, by Bach-Wilhelmj; and Academic Festival Overture, by Brahms, as well as several encores.

The second part of the program featured Tana Bawden, soloist, in the Piano Concerto in A Minor, Op. 54, by Schumann, with brilliant performance by pianist and orchestra alike; and the España, Rhapsody, by Chabrier.

The final portion of the program included selections from "My Fair Lady," by Loewe; "Moonglow" and Theme from "Picnic" arranged by Hayman, The Stars and Stripes Forever, by Sousa, and — as a fitting conclusion — the Stein Song by Frederic F. Bullard,'87.

Conclusion

This year's events mark the thirteenth Alumni Day and the fourteenth Commencement exercises to be recorded since April, 1945, by The Review's ninth editor. During the past dozen years the pattern of Commencement ceremonies has not changed appreciably, although the economic and military problems confronting today's graduates are quite different from those of June, 1945. The events of Alumni Day have gone through a number of changes, however. The steins and bottled beer are gone from the banquet, but then, so are the speeches.

This year's events were marked by a somewhat greater degree of pageantry than usual; they also had a maturity and quality not always found in Alumni gatherings. The presentation of the mace injected a bit of medieval tradition into the exercises of a very modern educational institution, and the concert performance of the Boston Pops Orchestra provided a very welcome innovation for concluding Alumni Day. If Alumni left Cambridge empty-handed, they could do so with pride and dignity.

The symposiums emphasized advances in physics and educational methods of teaching science. The dedication ceremonies of new laboratories for M.I.T again called attention to the theme of science and education. In a very real sense, therefore, Alumni Day, 1957, could be regarded as Karl Taylor Compton Day for the cardinal and gray.

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What makes this group service of more than passing interest is the fact that all have long been active in a very specialized phase of industrial operations, namely, direct and correlated problems associated with Engineered Atmospheres, a phase not to be confused with conventional 'air conditioning'. Operations such as drying, baking, curing, coating, laminating and other treatments of this character require that the 'atmosphere' surrounding the products during the operation — the processing conditions — must be carefully predetermined and then precisely created and maintained.

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ROSS ENGINEERING OF CANADA, LIMITED, Montreal, Can. A Canadian company serving Canadian industries since 1923, this company's work parallels that of J. O. Ross Engineering in the United States. In the fields of paper, plastics, rubber, textiles, metal-fabricating, foundries, Ross of Canada designs and constructs systems and units for providing the necessary "Engineered Atmospheres" for many of the processing steps in these industries.

ROSS MIDWEST FULTON CORPORATION, Dayton, Ohio. Particularly in connection with drying systems on paper machines, etc., there is generally a need for automatic temperature control of the heating surface and for positive drainage of condensate; auxiliary items such as separators, heat exchangers, sight-flow indicators, syphons, traps, etc., are necessary adjuncts. Ross Midwest Fulton has specialized in these engineered systems since 1926 and to date the majority of paper machines in the U. S. A. and Canada operate with their equipment.

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TREND OF AFFAIRS

(Continued from page 490)

Visiting Committee Report on Geology and Geophysics

■ The Visiting Committee on the Department of Geology and Geophysics* met in Cambridge on Tuesday, December 4, 1956, with the following members present: Messrs. Beadle, Desmond, Lord, Sherry, and Silverman. The following members of the Department and Administration met with the Committee for all or part of the discussions: Francis Bitter and George R. Harrison, Associate Dean and Dean, respectively, of the School of Science; Robert M. Kimball, '33, Secretary of the Institute; Robert R. Shrock, Head of the Department, and J. A. Stratton, '23, Chancellor. Messrs. Bannerman, Clewell, Gershinowitz, and Green of the Committee were unable to attend.

The Committee recommends that the Executive Committee:

1. Approve the appointment of four new professional staff members in 1957, or as soon thereafter as they can be found or trained, to bring the departmental staff to 20, the number mentioned in last year's Visiting Committee Report as "optimum to achieve the proper diversity and depth."

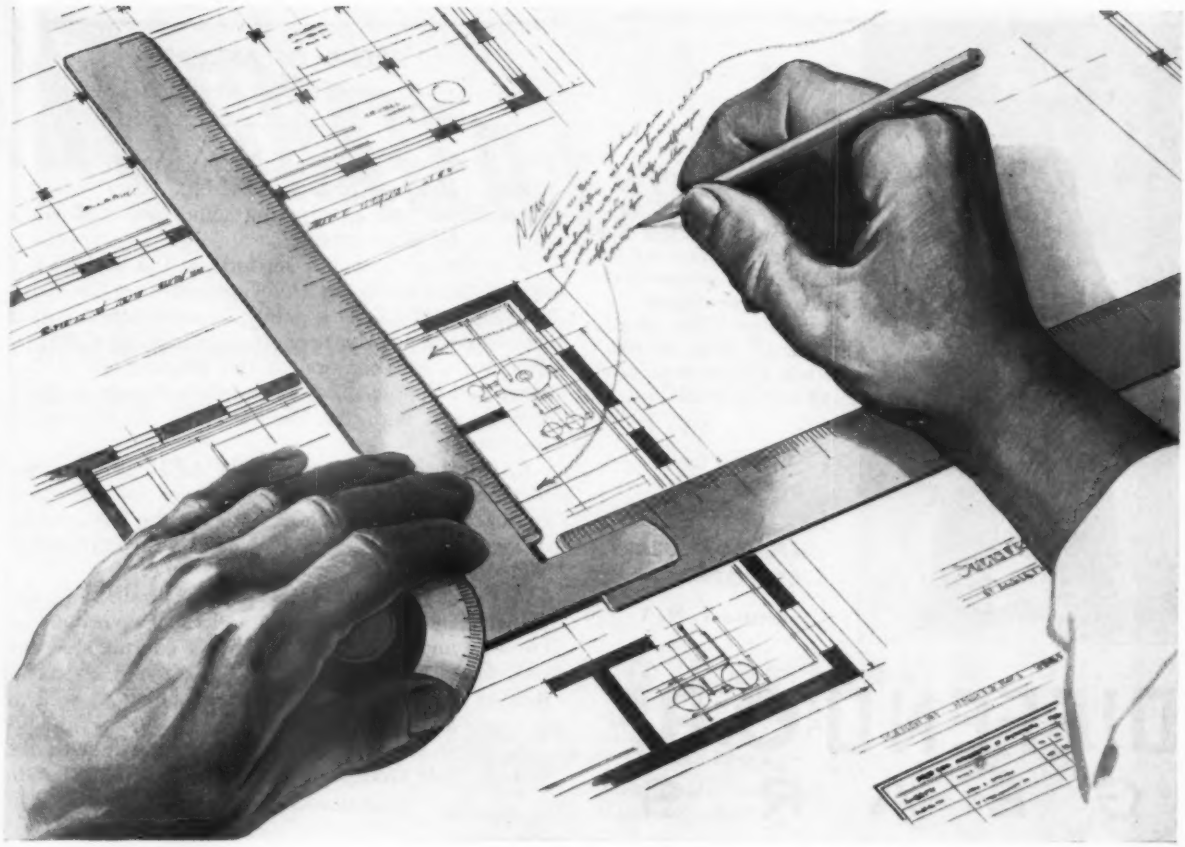
2. Approve continuance of the four year-five year curriculum in Course XII put into operation this fall for the purpose of offering a more fundamental and broader course of study, with such minor alterations as may be necessary to make it serve more effectively as a training course for students who may wish to continue graduate work in the earth sciences.

3. Give sympathetic consideration, within the recognized budgetary and space limitations, to the following needs of the Department: (a) adequate space for present and future staff including office and laboratory space, classrooms, and seminar rooms; (b) adequate library facilities in the departmental area; (c) a commons room for undergraduates; (d) budgetary support for a second instrument maker; (e) budgetary support for additional efforts to get more undergraduate and graduate students interested in going into the earth sciences.

4. Approve the Department's present and proposed future educational experiments which are designed to create and maintain interest in the earth sciences, specifically: (a) freshman elective subjects in earth science and astronomy, respectively; (b) undergraduate lecture subject in physical oceanography (offered by members of the Woods Hole Oceanographic Institution staff); biweekly departmental seminar; (c) biweekly earth science colloquim (with distinguished speakers, generally from outside the Cambridge area); (d) future subjects as follows: (1) second year subject in earth physics; (2) fourth year graduate sub-

(Continued on page 528)

*Members of this Committee for 1956-1957 are: Walter J. Beadle, '17, chairman, Thomas C. Desmond, '09, William J. Sherry, '21, Cecil H. Green, '23, Daniel Silverman, '29, Dayton H. Clewell, '33, Clifford S. Lord, '37, Harold M. Bannerman, and Harold Gershinowitz.



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(Continued from page 526)

jects in thermodynamics, hydrodynamics, electrodynamics, and mechanics, utilizing some of the present staff and anticipating some new staff additions to the Department.

5. Approve the policy set forth in the Interim Report of the Faculty *Ad Hoc* Committee on the Earth Sciences at M.I.T. This policy, broadly stated, is that the earth sciences be strongly supported at M.I.T. by effecting a collaboration of the Department of Geology and Geophysics with the Department of Meteorology and with the Woods Hole Oceanographic Institution.

6. Approve the proposal of the *Ad Hoc* Committee that an interdepartmental laboratory be set up to consolidate the research activities of the Department of Geology and Geophysics and the Department of Meteorology.

7. Consider merging, at an appropriate time, the Department of Meteorology and the Department of Geology and Geophysics so that a consolidated departmental administration can utilize staff and facilities to maximum advantage in teaching as well as in research.

8. Effect a closer working arrangement with the Woods Hole Oceanographic Institution in order to

(Continued on page 530)

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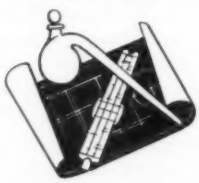

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TREND OF AFFAIRS

(Continued from page 528)

utilize its facilities for oceanography instead of attempting to duplicate such facilities.

These recommendations are evidence that the Committee is well impressed by what the Department has accomplished in the evolution of its educational program.

The report of the Visiting Committee was approved for publication in The Review at the meeting of the Executive Committee of the Institute on April 5.

Visiting Committee Report on Modern Languages

■ A wide range of topics was discussed by the members of the Visiting Committee on the Department of Modern Languages who met on March 21, 1956.* Committee members present were Messrs. Berke, Bond, Raymond, Twaddell, and Chairman Desmond. John E. Burchard, '23, Dean of the School of Humanities and Social Studies, and Paul M. Chalmers, Adviser to Foreign Students, were present and represented the Administration. In addition, the following members of the Department were also in attendance: William N. Locke, Head of the Department, Professors Joseph R. Applegate, A. Noam Chomsky, Morris Halle, James S. Tassie, and Victor H. Yngve.

Members of the Department described research and teaching activities being conducted under their direction, the purpose of teaching foreign language at the Institute was carefully examined, the occasional need to give a small group of foreign students a better grasp of English was discussed, and the place of foreign language work in the Humanities program was reviewed.

Students taking language courses at the Institute differ in their aims and, correspondingly, different types of courses are given. Graduate students wish to learn to read technical literature in their field. Literature and humanities courses appeal to those with broader interests and some knowledge of the language. Elementary language is taught for those who wish to begin to get the feel of a foreign language and culture. Subjects in spoken French and spoken German help provide ability in speaking. Linguistics courses attract those who want to make a study of the structure or the uses of language as a medium of communication.

Only undergraduates in Courses in Chemistry and in Mathematics are required, at the present time, to take a foreign language at the Institute. Almost all undergraduates taking language courses do so because they have a personal desire to acquire polylingual ability, not because it is required. Extracurricular activities, conducted in a foreign language, have been shown to be valuable as a supplement to classroom

(Continued on page 534)

*Members of this Committee for 1955-1956 were: John J. Desmond, Jr., chairman, B. Edwin Hutchinson, '09, Samuel Berke, '15, Antonio H. Rodriguez, '21, Horatio L. Bond, '23, Jean M. Raymond, '34, Franklin S. Cooper, '36, Elton Hocking, and W. Freeman Twaddell.

Another Graver Contribution to American Industry 1857-1957

IN 1884...73 YEARS AGO...

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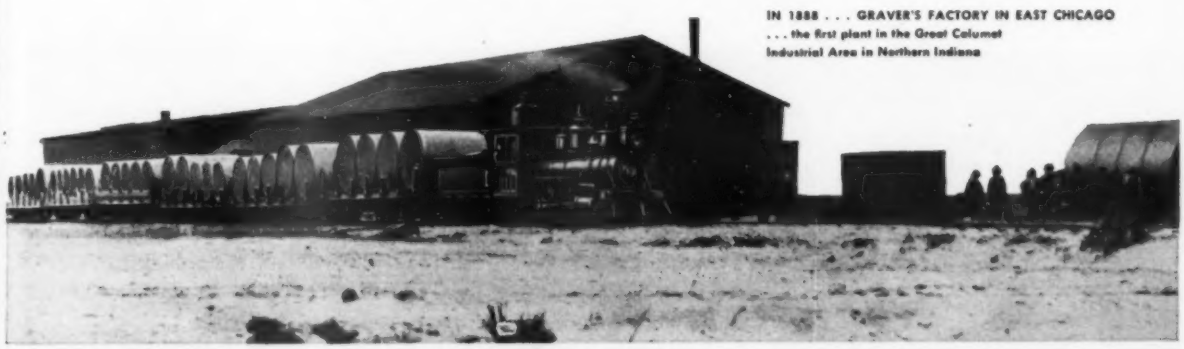
Quoted from an article "Graver Tanks Are Monuments to Confidence, Energy and Skill," The Southwestern Oil Journal, December 5, 1919:

"• • • It had been the theory of Chicago tank builders that tanks should be constructed like boilers—made of heavy material and capable of standing a great pressure. Mr. Graver could erect his tanks much cheaper than those being put up by the Chicago concerns, but he was unable to get his just share of the business. He took contracts for other kind of work and his perseverance was finally rewarded by a contract to build four linseed tanks of considerable size for a Chicago concern. Failure was predicted by his competitors and Joseph T. Ryerson, from whom he was purchasing the material, also became skeptical of the outcome.

Having called Mr. Graver into conference and being assured that he had successfully constructed the lighter tanks for the Standard Oil Company, Mr. Ryerson gave the oil company his word that the tanks would fill all requirements and Mr. Graver was allowed to go on with the contract. William Graver, his son, J. P. Graver, now president of the company and Mike Sheets, the construction foreman, got the material out for the tank at their plant in Clark street.

The tank trade was especially interested in the construction of the tanks and they gathered daily to watch the erection. Gloomy predictions were voiced from the laying of the bottoms to the completion of the tanks. However, William Graver had his day when the first tank was tested out. A large crowd was on hand to see the tank filled up, and as the gauge on the tank soared and it still held, many of his competitors turned on their heels, wiser apparently in tank construction.

It was upon the completion of this tank that William Graver began to reap the fruit of his labor. Orders came pouring in and from that day to this the Gravers have been favored with a large share of the tank business."



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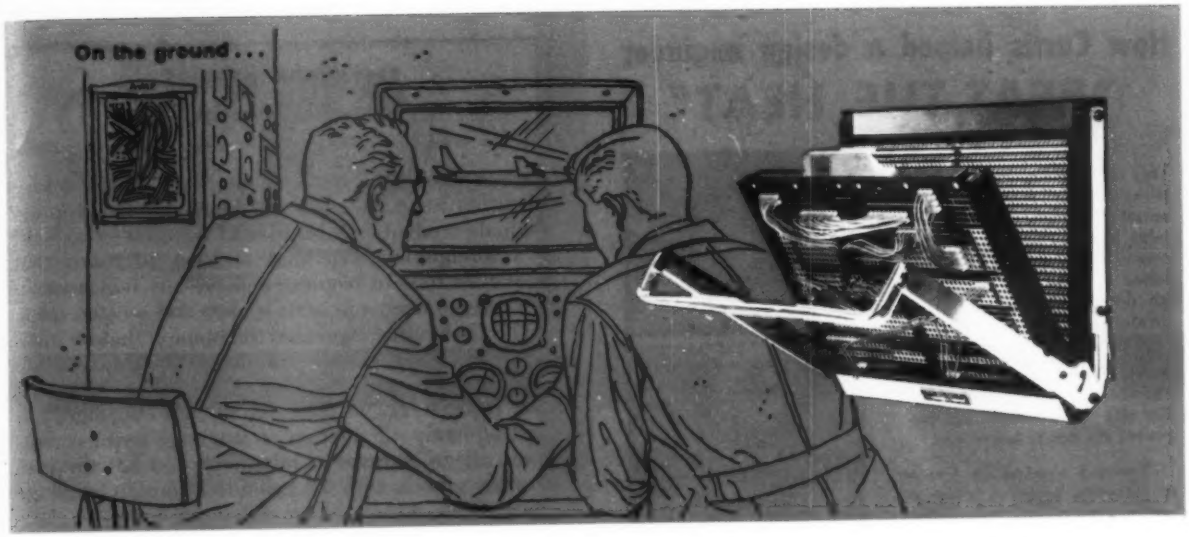

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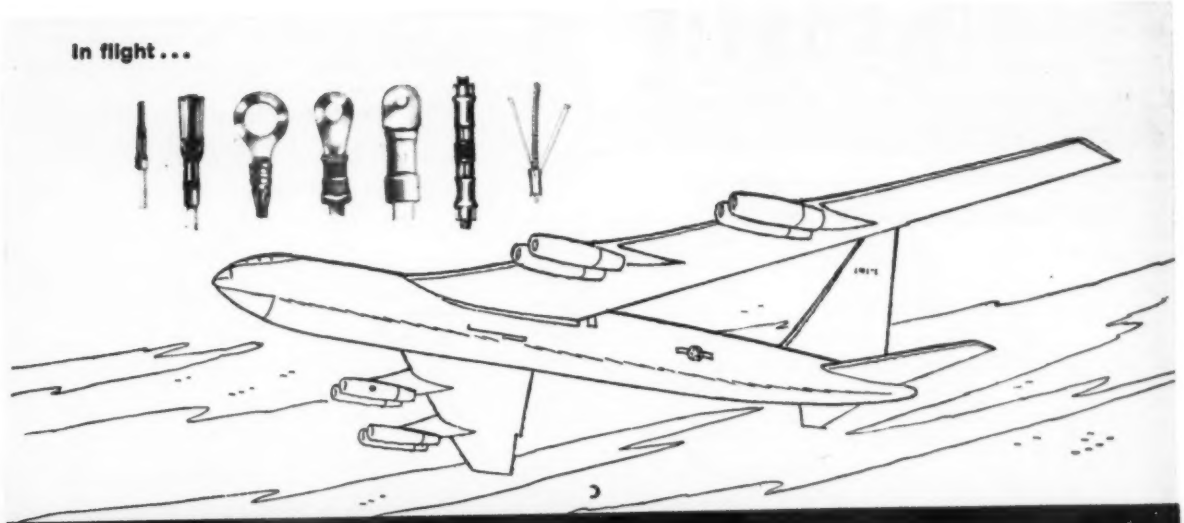

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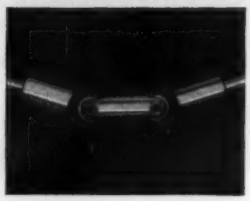

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TREND OF AFFAIRS

(Continued from page 530)

work in languages, but can rarely be a satisfactory substitute for it. It takes 150 hours for the average graduate student to learn to read material in his field in a foreign language and at least 10 times that amount of time to begin to achieve any real mastery of a foreign language in its spoken and written form.

The Committee expressed the opinion that an institution of higher education ought not to have to teach elementary language. Every educated man should have command of at least one foreign language, but too frequently elimination of language requirements from college entrance requirements has left the preparatory schools with the belief that foreign language ability is not important for college students.

In a few instances foreign students who come to study at the Institute have difficulties in keeping up with their studies because they are not sufficiently familiar with English. Although only a few such cases appear each year, it was suggested that an elective course in spoken English for foreign students could be established. (Such a course has since been approved by an appropriate Faculty Committee.)

Members of the Department of Modern Languages have a vital interest in effective use of both aural and visual instrumental aids to language teaching. The

(Continued on page 536)

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TREND OF AFFAIRS

(Continued from page 534)

high cost of production has ruled out the use of sound films, but the use of audio aids in language teaching in colleges and secondary schools has grown rapidly. School uses of audio aids would undoubtedly be enhanced if rugged and durable equipment, specifically designed for school use, were made available at prices intermediate between that of home and professional equipment. Efforts are being made to interest engineers and manufacturers in the development of suitable apparatus for teaching.

With its relatively small number of language students, the Institute has not yet initiated a "language laboratory," but is interested in developing such facilities. It has been amply proven that adequate laboratory facilities enable language students to derive much benefit from the laboratory work that supplements classroom instruction. Students are especially aided by recording facilities that enable them to listen to and imitate the voice of foreign speakers, and to make subsequent comparisons between the original and their imitation.

The Committee expressed the view that the Department is carrying on linguistic research which, in some cases, cannot be done at all elsewhere, and, in other cases, is conducting language research more efficiently than is being done elsewhere. The Committee reaffirms its 1955 recommendations that: (a) competence in at least one foreign language be required of every candidate for an M.I.T. degree; and (b) an admission language requirement be considered to encourage students to get that competence before entering, such a requirement to be put into effect gradually, giving secondary schools sufficient notice to prepare their students for it. The Committee suggests investigating the possibility of a freshman elective in spoken English for foreign students, such a course to be offered by members of the Department's staff. Finally, it is the Committee's hope that a "language laboratory" may soon be provided to aid in the development of spoken language proficiency.

After review by the Executive Committee in August and by the Corporation on October 1, 1956, the report of the Visiting Committee was submitted for publication in The Review on October 25, 1956.

Visiting Committee Report on Civil and Sanitary Engineering

■ The Visiting Committee on the Department of Civil and Sanitary Engineering met on Sunday, April 8, and Monday, April 9, 1956, at the Institute. Present at this meeting were: William V. McMenimen, '03, Horatio L. Bond, '23, Alfred E. Perlman, '23, and Alfred T. Glassett, '20, chairman.* Present from the

(Continued on page 538)

*Members of this Committee for 1955-1956 were: Alfred T. Glassett, '20, chairman, William V. McMenimen, '03, Clarence D. Howe, '07, Horatio L. Bond, '23, Alfred E. Perlman, '23, Philip C. Rutledge, '33, Wesley W. Horner, Frank D. Merrill (deceased), Hartley Rowe, and General James H. Stratton.

From Lilliput to Brobdingnag—

Via Research

Gulliver, with considerable aplomb, blithely traveled through the never-never land of giants as tall as church steeples and through the land of the little people, six inches tall. In these strange lands he unwittingly, but consistently, came a cropper.

As boiler makers, we too are confronted with strange lands. Boiler pressures have reached the supercritical, that area of pressures above 3,200 pounds per sq. inch where water and steam lose some of the behavior patterns we have known so well. Steam temperatures have increased, pressing the metallurgist to provide better materials to contain them. And all the while, boiler capacities have jumped by leaps and bounds. In short, the quest for greater efficiency has necessitated the development of boilers of Brobdingnagian proportions.

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There are many roads from Lilliput to Brobdingnag. The only sure one is the route of research. The ills that befell Gulliver are funny—only in a fable.

Architect's drawing of Eddystone Station

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TREND OF AFFAIRS

(Continued from page 536)

Administration were: Julius A. Stratton, '23, Chancellor; C. Richard Soderberg, '20, Dean of the School of Engineering; Robert M. Kimball, '33, Secretary of the Institute; Malcolm G. Kispert, 2-44, Executive Assistant to the President; John B. Wilbur, '26, Head of the Department. The heads of the various divisions within the Department were also present.

The Sunday meeting was held in the Faculty Club and convened at 2:00 P.M. At this meeting Dr. Wilbur reviewed the organization of his Department, the trends in enrollment, and the various research problems being carried on. In the death in 1955 of Donald W. Taylor, '34, Associate Professor of Soil Mechanics, the Department suffered a serious loss. Professor Taylor was outstanding in his field of soil engineering and considerable discussion developed as to his successor.

At the undergraduate level, student enrollment continues to be a matter of some concern. Dr. Wilbur explained to the Committee the various steps his Department has been taking to interest freshmen in this field. It was the opinion of the Committee that, in the field of civil engineering, there continues to be a substantial demand for students graduating in four years with a bachelor's degree and that the procurement and proper training of these students is a very important function of the Department of Civil Engineering.

Enrollment in the Graduate School continues to be satisfactory, with substantial numbers of applicants, and no problem is apparent at that level. Research in the many fields covered by the Department's activities continues to be satisfactory, both as to volume and scope, and the Committee was again happy to find that the research programs appear to be very effective as Graduate School instruction.

At the 1955 meeting of the Committee, Professor Wilbur outlined his ideas of a new approach to undergraduate teaching of civil engineering under which students start the professional subjects in their early years so that they may be encouraged to exercise judgment and imagination in their approach to engineering problems. At that time it was recommended that the proposed program of vertical education be tried on a partial scale, and this is currently being done in a sophomore course dealing with professional subjects. Experience to date has shown this new teaching concept to be educationally effective and popular with the students. It is hoped that, at a later date, this type of teaching can be further extended into the junior and senior years.

On Monday the Committee members met in the Department headquarters and were escorted to the various laboratories and divisions of the Department, following which discussions were held with all of the Faculty members. The Committee was greatly impressed with the various presentations made, and most particularly with the outside activities of many members of the Department.

(Continued on page 540)

Blueprint of Chicagoland Economic Opportunities

What industrial plant sites are available in Chicago and Chicago Heights? Where are they located in respect to transportation, shipping and other facilities? What materials are plentiful? What is the labor situation? What about housing —and schools?

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TREND OF AFFAIRS

(Continued from page 538)

After the Monday discussions the Committee had a meeting and submitted to the Corporation the following recommendations:

1. With the exception of the Hydraulic Engineering Division, which is housed in a separate building from the rest of the Department, there is a critical shortage of space in the Department. It is recommended that the space vitally needed for research by the Transportation Division be provided promptly;

2. Surveying is an important part of any course in civil engineering. With minor exceptions the surveying instruments now used for teaching are more than 35 years old and while still functional are not adequate to teach modern surveying. The Committee recommends that a replacement program for these instruments be initiated – the total cost of which will approximate $10,000;

3. Replacement for the late Professor Taylor, in the field of soil mechanics, is of prime importance. It is necessary that the new division head be an outstanding man in soil mechanics and that every effort be made to maintain the successful leadership this division has so long enjoyed.

The report of the Committee, issued May 10, 1956, was discussed by the Executive Committee in August, 1956, and reviewed by the M.I.T. Corporation at its meeting on October 1, 1956. On October 25 it was received for publication in The Review.

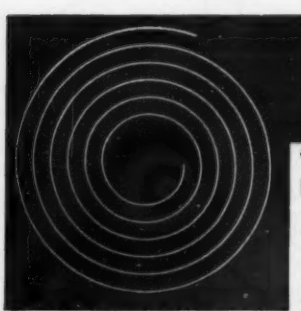
Little Lecture

■ Edwin H. Land, President of Polaroid Corporation (Cambridge), gave the 1957 Arthur Dehon Little Memorial Lecture on the evening of Wednesday, May 22, in M.I.T.'s Kresge Auditorium.

Dr. Land's lecture, entitled "Generation of Greatness: the Idea of a University in an Age of Science," discussed new concepts of scientific and technical education. It was open to the public and the attendance was greater than at previous lectures of its kind.

Inventor of the Land-Polaroid Camera and holder of more than 200 patents, Dr. Land is currently Visiting Institute Professor in M.I.T.'s School for Advanced Study. Prior to giving his lecture he spent

(Continued on page 542)



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TREND OF AFFAIRS

(Continued from page 540)

several weeks meeting with Faculty and administrative groups at M.I.T. to examine various aspects of teaching which are affected by rapidly changing scientific and technological concepts.

Established in 1944, the Arthur Dehon Little Memorial Lectures honor the memory of one of M.I.T.'s most distinguished Alumni. Dr. Little, a graduate of the Class of 1885, was known as an accomplished scientist who was also always greatly concerned with the social implications of scientific advance.

Previous lectures in the memorial series have been given by such outstanding men as Sir Edward V. Appleton, Dr. Detlev W. Bronk, Sir Henry Tizzard, and Dr. J. Robert Oppenheimer.

Blobs of Bronze

■ Twenty-one sculptures by Ibram Lassaw, who works with wire and a welding torch instead of with clay or stone, went on exhibit at the Institute in mid-May. The exhibition remained on display in the New Gallery of the Charles Hayden Memorial Library through June 16, and was available for Alumni Day visitors to see.

Non-objective constructions, consisting of intricate metal mazes coated with bright blobs of bronze, have attracted wide attention. Some stand as high as a man or higher and some are suspended from the ceiling.

One of the works, "Pillar of Cloud," was done on commission for Temple Beth-El in Providence. (The sculptor executed a 28-foot "Pillar of Fire" for Congregation Beth-El in Springfield, Mass.) Another, "Nebula in Orion," is from the collection of Mrs. John D. Rockefeller, III, and another, "Alcor," belongs to Mrs. Laurance Rockefeller.

Lassaw was born in Egypt but has been in this country since he was eight years old and is a citizen of the United States. He studied in Brooklyn and New York, where he now has a studio. He is currently working on commissions for a Roman Catholic Church in Centreville, Ohio, and a synagogue in Port Chester, N.Y.

(Concluded on page 544)

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TREND OF AFFAIRS

(Concluded from page 542)

Review of R.O.T.C.

■ Annual military day exercises were held at the Institute on May 7 with the main event of the day a parade and review on Briggs Field at 4:00 P.M. During this ceremony 41 cadets of the Departments of Military Science, Naval Science, and Air Science at M.I.T. were presented awards and medals for outstanding achievement.

Admiral Edward L. Cochrane, '20, U.S. Navy (Retired), Vice-president for Industrial and Government Relations at M.I.T., was reviewing officer.

Dignitaries in the reviewing stand included Major General William M. Morgan, U.S. Air Force, Commander of the Air Force Cambridge Research Center; Colonel James S. Morgan, U.S. Army, Representing Chief of the Massachusetts Military District; John E. Burchard, '23, Dean of the School of Humanities and Social Studies, M.I.T.; Colonel James R. Lyons, U.S. Air Force; Colonel Charles McAfee, Jr., U.S. Army, Head of the Department of Military Science and Tactics, M.I.T.; Colonel Harmon Lampley, U.S. Air Force, Head of the Department of Air Science and Tactics, M.I.T.; and Captain Joseph S. Lewis, Head of the Department of Naval Science, M.I.T.

The formation included about 1,600 cadets. Music was provided by the R.O.T.C. band under the direction of Major Frederick A. Harris.

THE STREAM OF LIFE

(Concluded from page 494)

In recent years, there has been much discussion of the importance of "peace of mind." Few creatures with minds have more peace than the koala bear or the opossum. What we need is not peace of mind but security of spirit, which is not at all the same as freedom from all anxiety.

We must grow with our universe. Its increasing complexity brings greater opportunity. The world is fuller of things that we consider good than philosophers of earlier days ever dared to expect. Man is being led into new fields of awareness, new challenges of attainment and new possibilities of destiny. As he awakens further and his competence and wisdom grow, he is able to control vaster reaches of his environment, and he is given the opportunity to make greater mistakes and learn to achieve ever greater victories. God's creatures are being pulled slowly in the direction of their needs in accordance with their ability to fit in with the whole of nature. This basic law is embodied in the maxim "Be of good courage, I have overcome the world." You have been given, to each in his own degree, the blessings of intelligence, imagination, and spiritual discernment. These three will carry you far.

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EQUALITY AND EXCELLENCE

(Continued from page 495)

But a scaling down of our exaggerated emphasis on college education is only part of the answer. Another important part of the answer will surely be a greatly increased emphasis upon individual differences, upon the many kinds of human talent, and upon the immensely varied ways in which individual potentialities may be realized. If we are really serious about equality of opportunity, we should be infinitely serious about individual differences; because what constitutes opportunity for one man is a stone wall for the next man. Individuals differ vastly from one another, and they differ in innumerable ways. If we are to do justice to the individual, we must seek the kind of education which will open his eyes, stimulate his mind, and unlock his potentialities. There is no formula for this, and it may or may not involve what we now think of as a college education.

If we did develop such an indomitable concern for individual differences, then we would learn to laugh at the assumption that a college education is the only avenue to human dignity and social worth. We would educate some youngsters by sending them on to college. We would educate others in other ways. We would develop an enormous variety of patterns to fit the enormous variety of individuals. And no pattern would be regarded as socially superior or involving greater human dignity than any other pattern.

As long as the present heterogeneity of the college population exists – and it is most unlikely to diminish – then the only path open to us is to achieve even greater diversity in our higher educational system than now exists to correspond to the diversity of the clientele. There is no other way to handle within one system the enormously disparate human capacities, levels of preparedness, and motivations which flow into our colleges and universities.

And such diversity has more than raw necessity to commend it. The diversity within and among institutions which will permit individuals of differing gifts and differing bents to realize their varied potentialities can be a positively constructive attribute of our system. Specifically, it can aid us in the important business of stressing the many kinds of achievement of which the human is capable.

In seeking to promote such stress upon varied forms of achievement, we shall be abetted by a natural tendency in human beings to discriminate many kinds of abilities and to exploit many diverse sources of self-esteem. Given an opportunity, people will find self-esteem in the most astonishing variety of performances. This should be encouraged. The sort of capacity measured by the conventional college aptitude test is very important, but instead of putting a more and more monolithic emphasis upon this sort of talent, we should encourage all kinds of individuals to run on all kinds of tracks. In this way we can distribute very widely the rewards of self-esteem and self-respect which are the healthiest preventives of leveling reactions and can encourage on the broadest scale the release of energy and

(Concluded on page 548)

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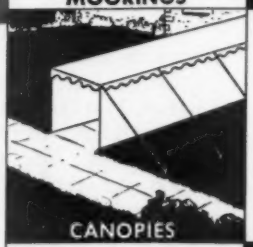

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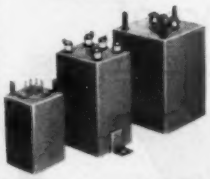

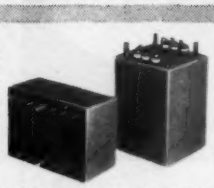

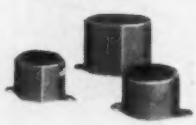

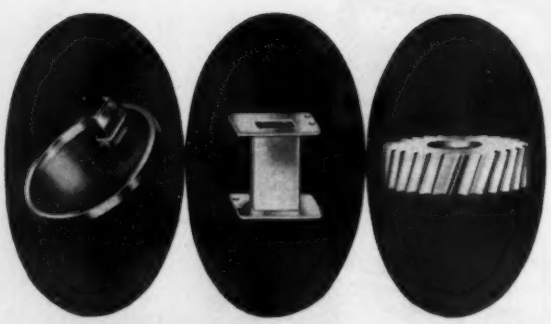

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EQUALITY AND EXCELLENCE

(Concluded from page 546)

positive motivation on the part of the individual which have been the great strength of our society.

Then, unhampered by popular attitudes disparaging excellence, we can dedicate ourselves to the cultivation of distinction and a sense of quality. We can demand the best of our most gifted, most talented, most spirited youngsters. And we can render appropriate honor to that striving for excellence which has produced so many of mankind's greatest achievements.

IN KNOWLEDGE LIES SECURITY

(Concluded from page 496)

all disaster – the wealth of the spirit and of the intellect.

But with these gifts go responsibilities that you must not ignore. Our society desperately needs the leadership, guidance, and statesmanship that you have to give. We need your leadership not only in research, but in the applications of research to our national security and to the public welfare. We need your guidance in resolving the tremendous problems which result from the impact of scientific discovery upon our civilization. You must be concerned with these matters which lie outside the narrow domain of your professional activity; you have an obligation to participate personally in affairs of the community and the nation. As Judge Charles Wyzanski expressed most eloquently to our graduating class a few years ago, the professional man must, over and above the resources of his intellect and experience, be imbued with a desire to contribute to the common account.

And since such a readiness to contribute to the common account is the hallmark of the professional man, let it be said of you at the end of your life that you achieved success not only in your technical competence, but that you also met your obligations to your fellow man with courage and honesty. We who have worked with you through these years know that you will keep that trust. I join with your families and friends in wishing you Godspeed.

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EDUCATIONAL METHODS AND TODAY'S SCIENCE — TOMORROW'S PROMISE

(Concluded from page 503)

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Fig. 4† shows that there are the circular waves from one source.

Fig. 5† illustrates what happens when there are two sources going together, and in phase. If there are any engineers in the house they will see the interference pattern of two antennas, and some of them will see how the phase changes at the nulls in Fig 6.†

We have also made a slide which shows diffraction by a slit or, if there is an engineer in the house, it shows why you can hear sound behind the door.

Now to end.

Some kits are prosaic, but many experiments, like one you saw, require a superb vacuum. To ensure that the students can make experiments like the Nobel Prize winning experiments of our century, we have made a model of a vacuum tube enclosed in an evaporated milk can, and the cost of the parts is about $0.75. Some very new vacuum techniques make this possible today, whereas a year ago no one would have believed it.

Now you can see that we are going to try to enable the general public to participate in the greatest intellectual achievements of modern man while they go on. And for those students who are attracted into science, we hope that in this direct participation they learn the essential humility of the scientist. In summary, that humility is, "It's better to light one candle than to complain of the darkness."

*Illustration on page 502.
†Illustration on page 503.

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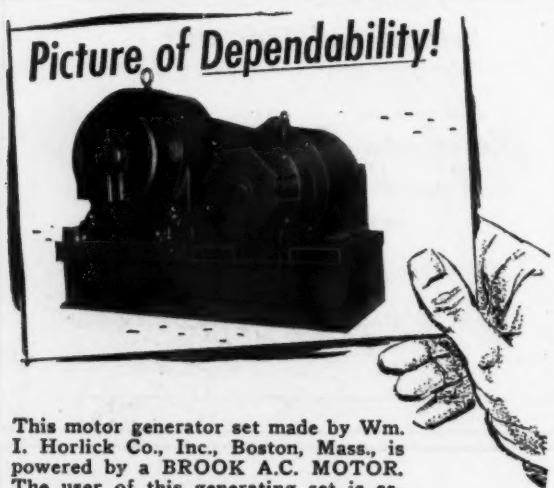

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PRESIDENT'S REPORT

(Continued from page 506)

in October, for a new $800,000 building adjoining the Armory as part of the Du Pont Memorial Sports Center. The Du Pont Memorial Center will have facilities for six of the eighteen sports at M.I.T. including six squash courts and space for wrestling and fencing. It will also contain facilities for women and a locker room for faculty members. These new facilities have been made possible by the very generous bequest of young David F. duPont, '56, who met tragedy in an automobile accident in 1955, only a few days after reaching his twenty-first birthday.

Faculty Salary Adjustment

Finally, and tenth, I come to our continuing obligation to maintain those conditions of compensation, recognition, and reward which are essential if we are to maintain here an environment which will attract and hold first-rate teachers. Such an environment is characterized by many subtle qualities: the standards of excellence which prevail, the interaction and interstimulus of first-rate minds, an atmosphere of creativity and professional advance, the status of dignity and freedom the members of our Faculty have and feel they have. It involves all the subtle and imponderable factors which enable a group of scholars to make a great university, when otherwise the same group might constitute a mediocre one.

We seek to maintain and enrich all of these environmental conditions, but just now the overriding need is to achieve an adequate level of faculty compensation. Under conditions of present shortages of manpower in the fields represented at the Institute and in the face of the growth that must come in the American system of higher education, it is becoming steadily more apparent that first-rate scholars and teachers are becoming one of the scarcest talents in the United States.

Many young men graduating with advanced degrees may now obtain positions at the start of their careers paying higher salaries than their experienced teachers receive. The discrepancy betwen industrial and academic salaries is greater in the fields of engineering and science than any others, and this gap threatens to divert too many able, young engineers and scientists from electing academic careers when they might otherwise wish to. If talented young people are to be attracted into academic careers, such conditions must be remedied.

In the face of M.I.T.'s need to meet this problem squarely and as evidence that we can do something about it, I have an important announcement to make. Alfred P. Sloan, Jr., '95, through the Alfred P. Sloan Foundation, Inc., has offered to make a grant to M.I.T. of up to a million and a quarter dollars towards a five-million-dollar fund for Faculty salaries provided the Institute obtain three and three-quarter million dollars from other sources. Mr. Sloan has long been an advocate of adequate compensation

(Concluded on page 554)

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PRESIDENT'S REPORT

(Concluded from page 552)

for creative talent in both industry and education, and as a member of the M.I.T. Corporation he has taken the lead in finding ways to increase Faculty compensation.

The Corporation has accepted the challenge of this generous and timely offer of Mr. Sloan's, and in the past few months we have quietly secured in gifts and pledges more than a million dollars toward the three and three-quarter million dollars we must raise. With this encouraging start, we now undertake a special and concentrated drive to secure the remaining two and three-quarter million dollars which will insure the full amount from the Sloan Foundation and thus will enable the Institute to meet the total goal of a five-million-dollar Faculty Salary Adjustment Fund. I make this announcement in full confidence that we can achieve this objective and that therefore we can take a decisive step to enable M.I.T. for the first time in its history to have a Faculty salary scale for which we need not be apologetic. Thus we take the first major step in preparation for our 100th birthday.

In these ten areas I have touched upon are a few examples of the new requirements and the unfolding opportunities which lie before us. They illustrate Rogers' vision of education constantly anticipating and adjusting to the needs of the future.

M.I.T. stands today at the very height of her powers, bidding fair, if she exerts herself vigorously and wisely further to augment her excellence, her creativity, and her leadership. She could slip from this eminence, too, if she — if we — fail to meet the increasing requirements our society exacts of its leaders, both institutions and men, or if she sets her sights too low and becomes content with little plans, limited aims, and paltry means. If our past really proclaims our future, we will not fail to achieve these new goals and meet the new requirements which rest upon us.

In Virginia there is a mountain, the highest in the state, which bears the name of William Barton Rogers. In education and in the concept of this institution he framed, we have another towering mountain; and as we push up its slopes, we realize how great and exhilarating has been the climb so far and the challenging, unclimbed heights which lie ahead.

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and the prophet replied:
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The tale is told of Almustafa, the prophet, who, having awaited for many years the ship that would return him to the place from whence he came, was making the final descent to the shore when the folk of Orphalese crowded about him. They besought him before departing to "disclose us to ourselves, and tell us all that has been shown you of that which is between birth and death."

With words of wisdom, an answer appropriate was given to the woman holding a baby, to the ploughman, to the merchant. Begged one, "Speak to us of GIVING," and the prophet replied:

> "It is well to give when asked, but it is better to give unasked, through understanding;
> And to the open-handed the search for one who shall receive is joy greater than giving. All you have shall some day be given;
> Therefore give now, that the season of giving may be yours and not your inheritors'."

Through the years the prophet's words have held true, for even today he who "through understanding" includes the MASSACHUSETTS INSTITUTE OF TECHNOLOGY as a beneficiary in his will can experience thereby a two-fold satisfaction. The successful culmination of his search for a worthy recipient and the anticipated results his generosity will assist in accomplishing. These satisfactions give an added value to the span of man's days and project his usefulness to his fellowmen far into the future.

The Massachusetts Institute of Technology because of the high quality of the education given its students, its effective research work for aiding America in peace as well as in war, and the high character of its governing body and academic staff qualifies as an institution for serving our American ideals for the present and in the years to come.

But the search, the finding, and the anticipated accomplishments are not enough; for without the properly-worded record, man's plan for the future may go awry. Hence the prophet's importuning, "—give now," should be heeded. The giving need not be an immediate physical transaction, for written directions replace the spoken word when the speaker is no longer present, and a donor can frequently make by will a gift which is larger than he can make while living. Truly, *"it is well to give when asked, but it is better to give unasked, through understanding."*

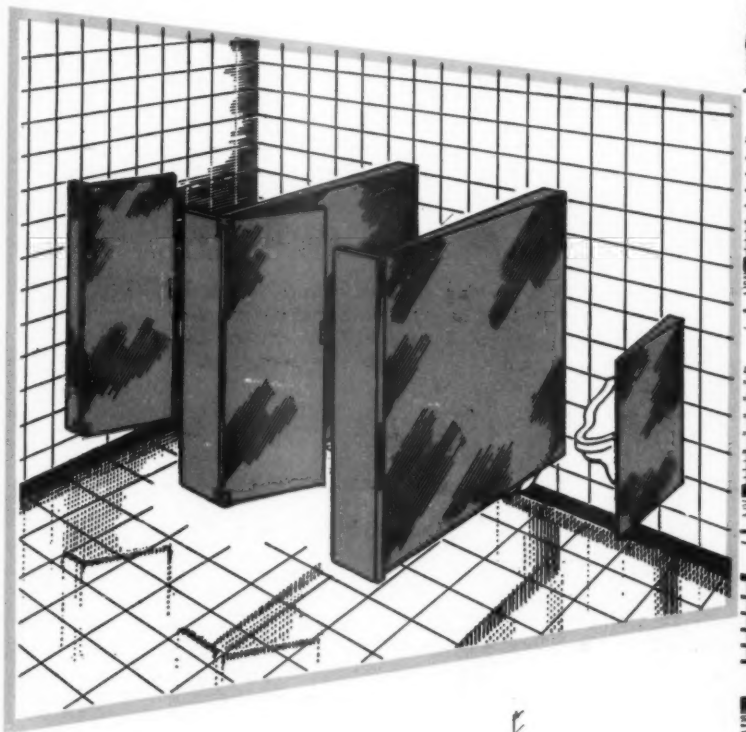
A booklet "Gifts by Will," outlining different forms of bequests to M.I.T., is available to you or to your attorney by writing to:

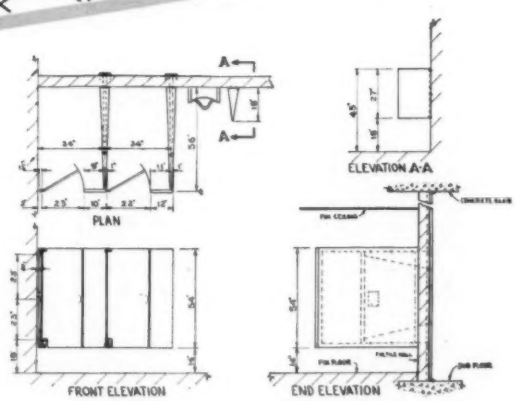
Director of Development
Massachusetts Institute of Technology
Cambridge 39, Massachusetts

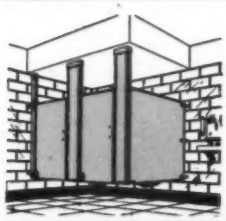
* "The Prophet" by Kahlil Gibran

The Partition of Tomorrow in Stainless Steel and Enamel

The FLUSHWING partition in stainless steel or galvanized, bonderized steel with baked enamel finish, is the newest member of the Flush-Metal family of fine products. . . . Unquestionably the most sanitary and distinctive design available with a lifetime of use built into each component unit. Such deluxe features as built in double capacity paperholders and built in ash trays can be incorporated in the construction. . . . The wall support for Flushwing partitions consists of a vertical member with cantilever arms built into the wall. The Flushwing units are installed with concealed fastenings after the room is completed. . . . Due to the care required in layout and installation, Flushwing units will be furnished in those areas where the factory can handle directly all details of engineering and installation. For further information and specification, please contact the home office.







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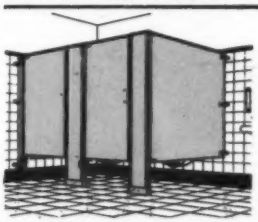

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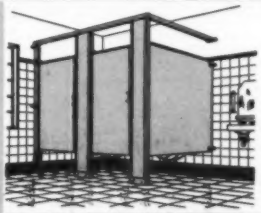

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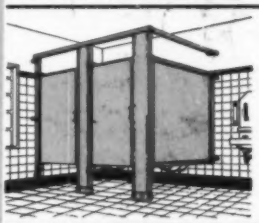

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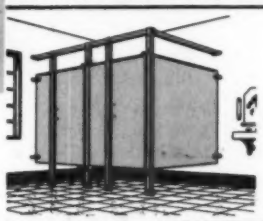

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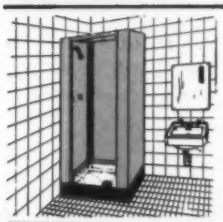

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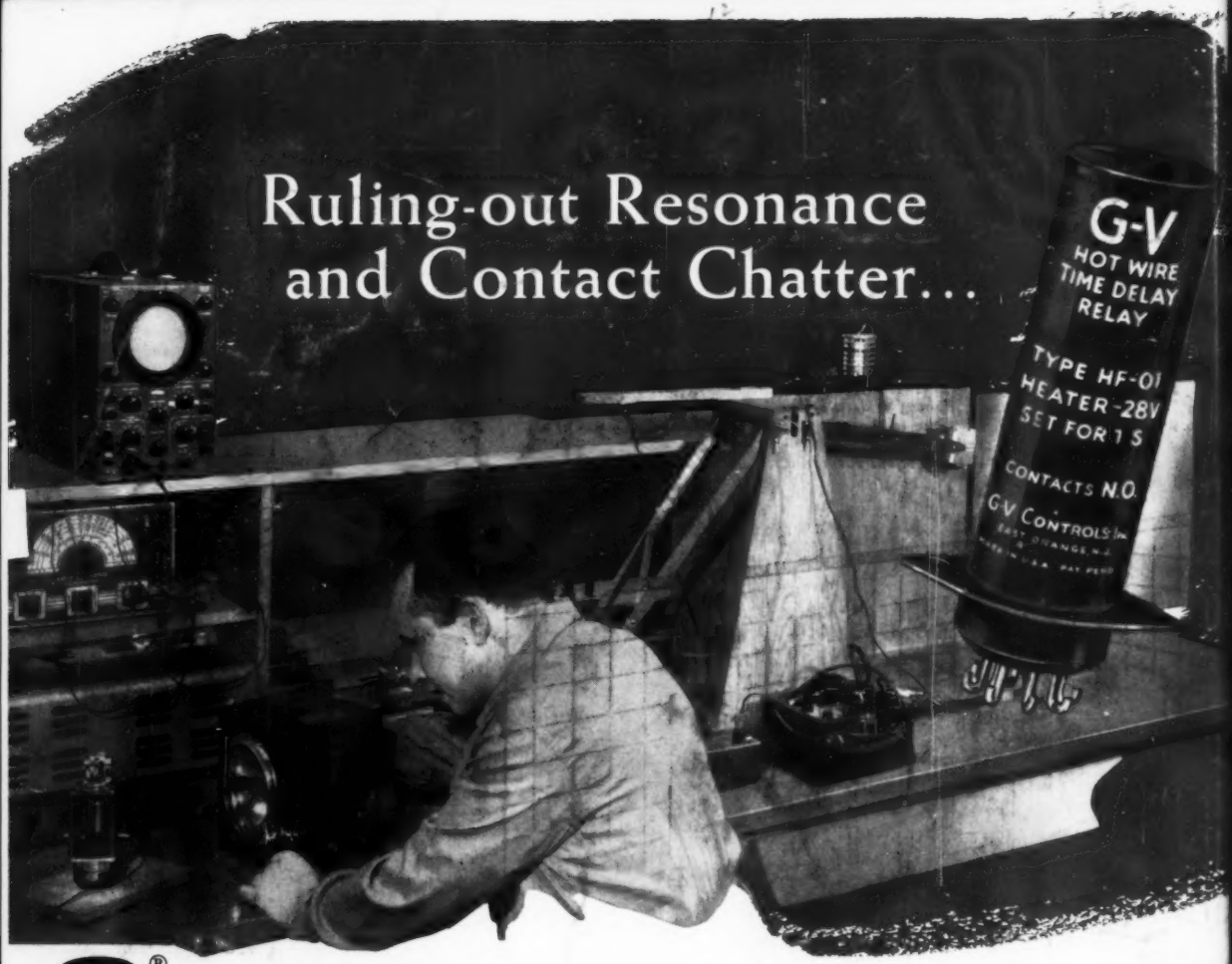

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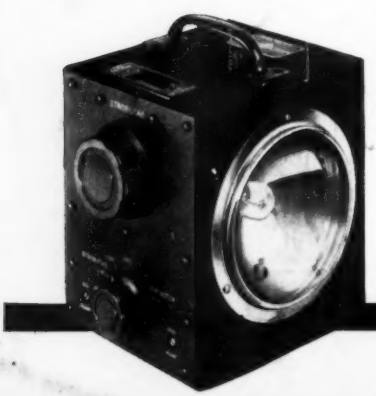

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With the Strobotac, they could *SEE* the sources of vibration and the reactions of the entire structure. From there it was easy to make design changes which would eliminate resonance or boost the resonant point to a value above the resonance-free range required.

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